AD-A099 953 PEAT MARWICK MITCHELL AND CO SAN FRANCISCO CALIF F/6 1/2
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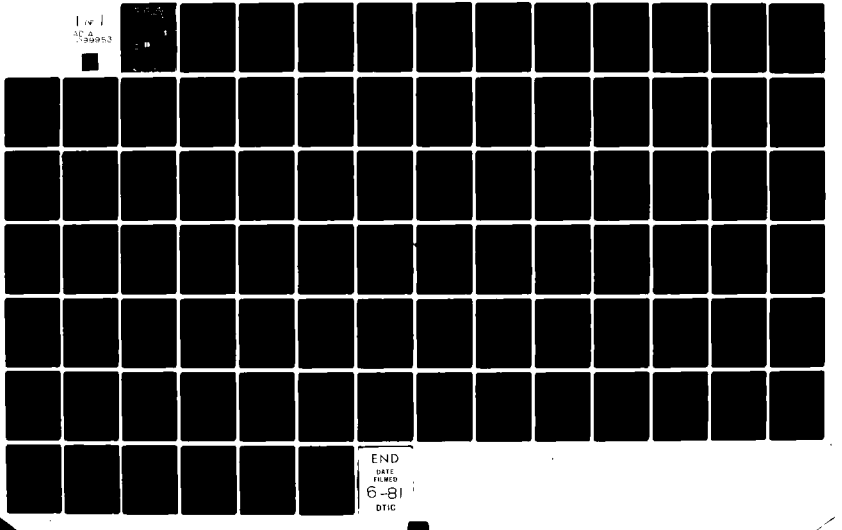
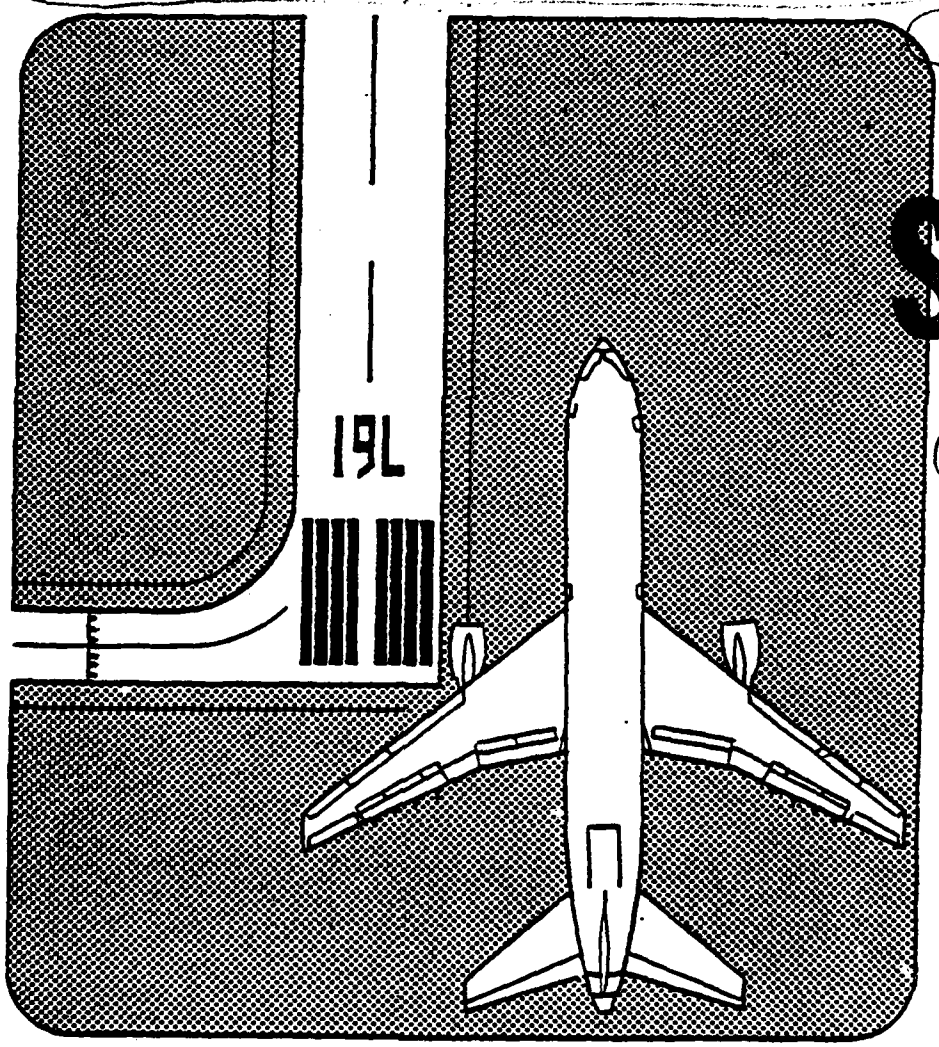


SAN FRANCISCO INTERNATIONAL AIRPORT

DATA PACKAGE Number 3.

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES.

LEVEL III



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PMM&Co. Peat, Marwick, Mitchell & Co.

OCTOBER 1978

PEAT, MARWICK, MITCHELL & Co.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

October 30, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: San Francisco Data Package No. 3

Dear Ray:

Enclosed is data package No. 3 for San Francisco International Airport. The package contains the results of the Stage 1 delay experiments (Attachment A) and an input data package for Stage 2 experiments (Attachment B).

These data should be reviewed by the San Francisco Task Force during the October 31, 1978 Task Force meeting.

Sincerely,

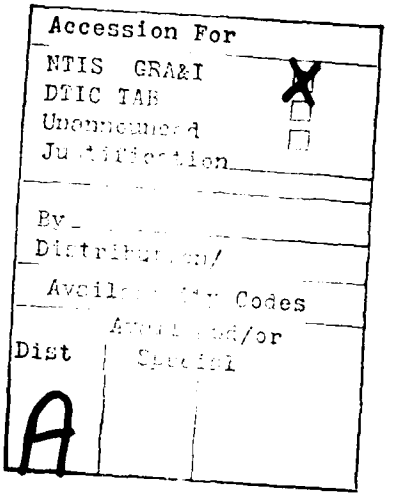
Stephen L. M. Hockaday
Manager

SLMH/sq
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. B. Drotts (ASO-4) (w/encl)

Attachment A

RESULTS OF STAGE 1 DELAY EXPERIMENTS



San Francisco International Airport

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.
San Francisco, California

October 1978

Table A-1

STAGE 1 EXPERIMENTS
San Francisco International Airport
Airport Improvement Task Force Delay Studies

Experiment Number	Page Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
1	4	ASM	28L, 28R, 1L	1L, 1R, 28L	VFR 1	1977	Today	None
2	7	ASM	28L, 28R, 1L	1L, 1R, 28L	VFR 2	1977	Today	None
3	10	ASM	28R	1L, 1R, 28L	IFR 1	1977	Today	None
4	13	ASM	28L, 28R	28L, 28R	VFR 1	1977	Today	None
5	16	ASM	28R	28L	IFR 1	1977	Today	None
6	19	ASM	19L, 19R	10L, 10R, 19R	VFR 1	1977	Today	None
7	22	ASM	19L	10L, 10R	IFR 1	1977	Today	None
8	25	ASM	19L, 19R	19L, 19R	VFR 2	1977	Today	None
9	28	ASM	19L	19L, 19R	IFR 2	1977	Today	None
10	31	ASM	19L	19L, 19R	IFR 2	1977	Today	Extend Taxiways L and V
11	34	ASM	19L, 19R	10L, 10R, 19R	VFR 1	1977	Today	Extend 1L/19R, VASI on 19R
12	37	ASM	19L, 19R	10L, 10R, 19R	VFR 1	1977	Today	Extend Taxiway K; 10L/10R departs
13	40	ASM	28L, 28R	1L, 28L	VFR 1	1977	Today	Utility runway on Taxiway L
14	43	ASM	28L, 28R	1L, 28L	VFR 1	1977	Today	None
15	46	ASM	28L	28L, 28R	VFR 1	1977	Today	None
16	49	ADM	n.a.	n.a.	n.a.	1977	Today	None
17	53	ADM	n.a.	n.a.	n.a.	1977	Today	None
18	57	ASM	28L	28L, 28R	VFR 1	1977	Today	Utility runway on Taxiway C

Table A-2

DELAY SUMMARY
STAGE 1 AIRFIELD SIMULATION MODEL EXPERIMENTS

Experiment Number	Page Number	Weather	Demand	ATC Scenario	Experiment Description	Runway Delay (Minutes) Arrivals Max. Average	Arrivals Average Daily[a]	Departures Max. Average	Departures Average Daily[a]
1	4	VFR1	1977	Today	Baseline	0.9	0.5	2.7	1.6
2	7	VFR2	1977	Today	Baseline	4.3	1.2	3.3	1.8
3	10	IFR1	1977	Today	Baseline	114.7	53.9	1.2	0.9
4	13	VFR1	1977	Today	Baseline	1.2	0.7	5.4	2.3
5	16	IFR1	1977	Today	Baseline	115.7	55.3	4.4	1.3
6	19	VFR1	1977	Today	Baseline	2.5	0.9	5.9	2.9
11	34				Extend 1L/19R, VASI on 19R	1.2	0.6	6.3	3.1
12	37				Extend Taxiway K, 10L/10R Departs	1.1	0.9	2.5	1.6
7	22	IFR1	1977	Today	Baseline	45.6	14.5[b]	80.5	43.2[b]
8	25	VFR2	1977	Today	Baseline	4.2	1.2	21.7	9.8
9	28	IFR2	1977	Today	Baseline	36.7	12.2[b]	120.2	54.2[b]
10	31				Extend Taxiways L and V	36.8	12.1[b]	136.2	56.6[b]
14	43	VFR1	1977	Today	Baseline	1.3	0.7	10.9	4.5
13	40				Utility Runway on Taxiway L	0.7	0.3	3.6	1.7
15	46	VFR1	1977	Today	Baseline	16.9	7.7	5.8	3.1
18	57				Utility Runway on Taxiway C	5.0	1.8	3.9	2.1

a. 15-hour daily average (0600-2100) except as noted.
b. 7-hour daily average (0600-1300).

Experiment No. 1

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR1 weather:

Arrival Runways	Departure Runways
28L, 28R, 1L	1L, 1R, 28L

Related Comparison Experiments:

Experiment No. 2 has the same runway configuration, but in VFR2 weather.

Results:

Figure 1A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 1B shows that average delays to aircraft using the runways are as high as 2.7 minutes per aircraft. Peak hour average delays are 0.9 minutes for arrival aircraft and 2.7 minutes for departure aircraft.

Figure 1C shows that the peak-period average delays to aircraft using the taxiways are 0.4 minutes for taxi-in operations and 0.2 minutes for taxi-out operations.

Figure 1D shows that average aircraft taxi travel times vary from 2.4 to 6.5 minutes. Peak-hour average taxi travel times are 3.6 minutes for arrival aircraft and 6.5 minutes for departure aircraft.

FIGURE 1A AVERAGE RUNWAY FLOW RATES

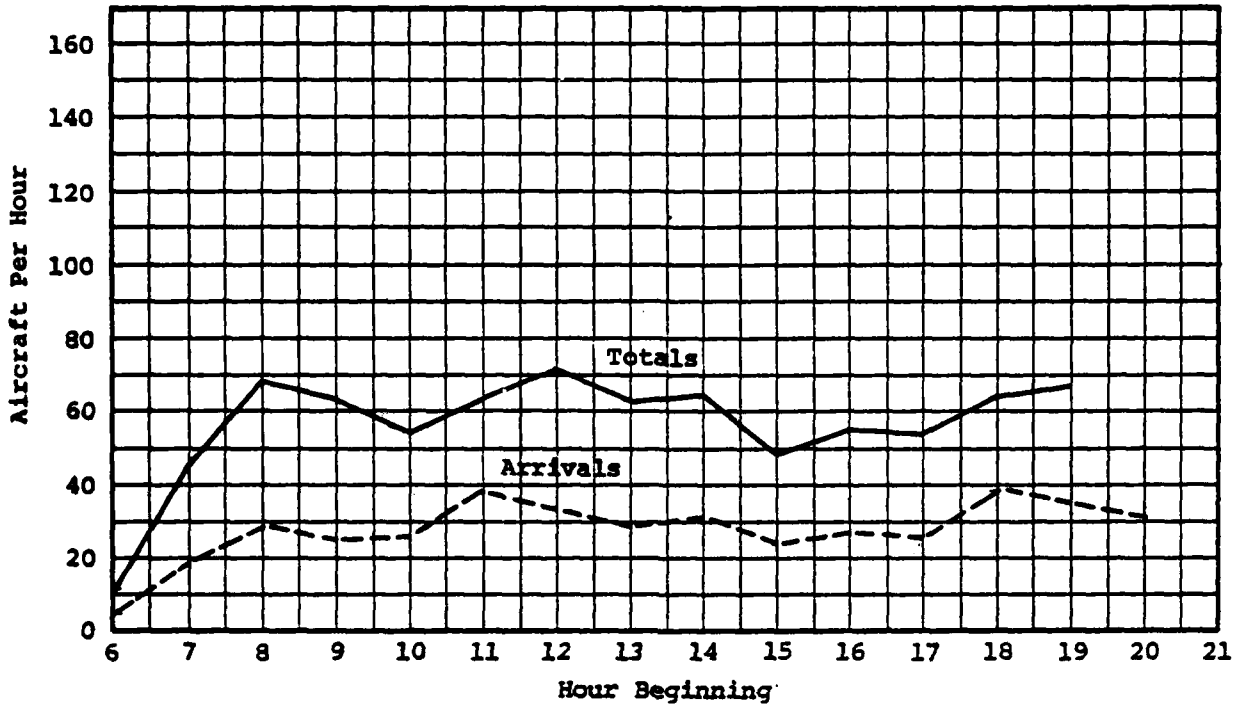


FIGURE 1B AVERAGE RUNWAY DELAYS

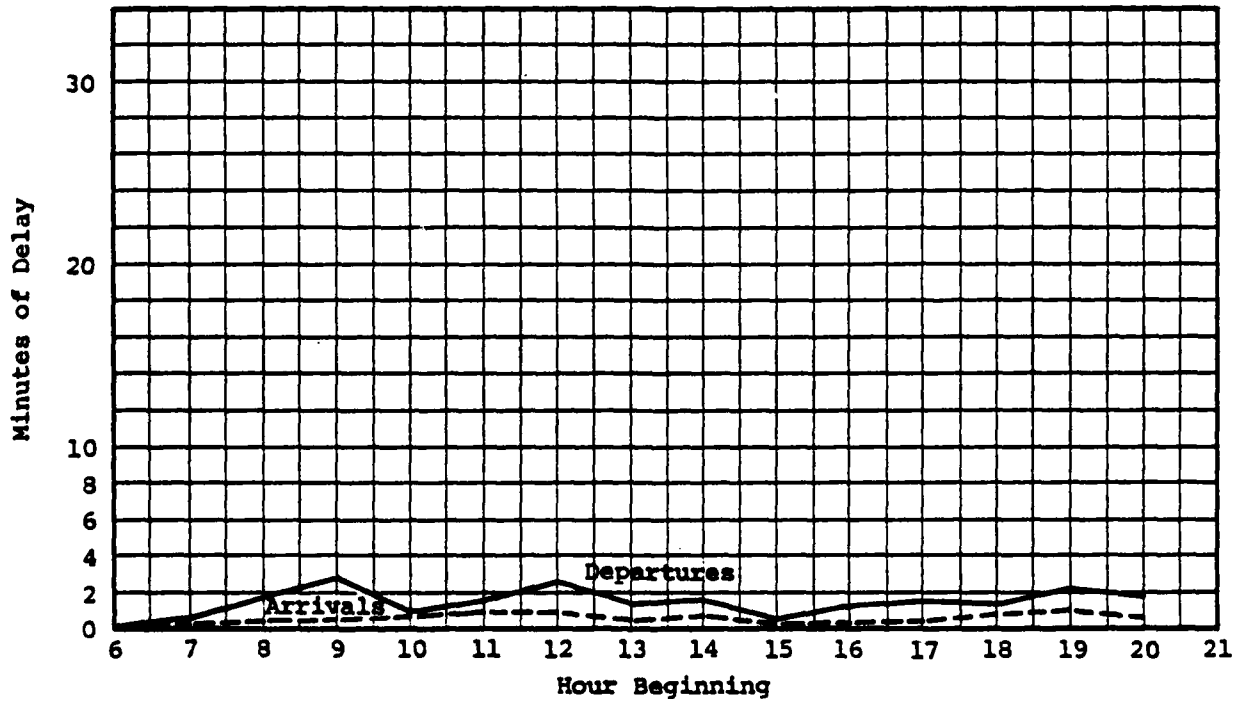


FIGURE 1C AVERAGE TAXIWAY DELAYS

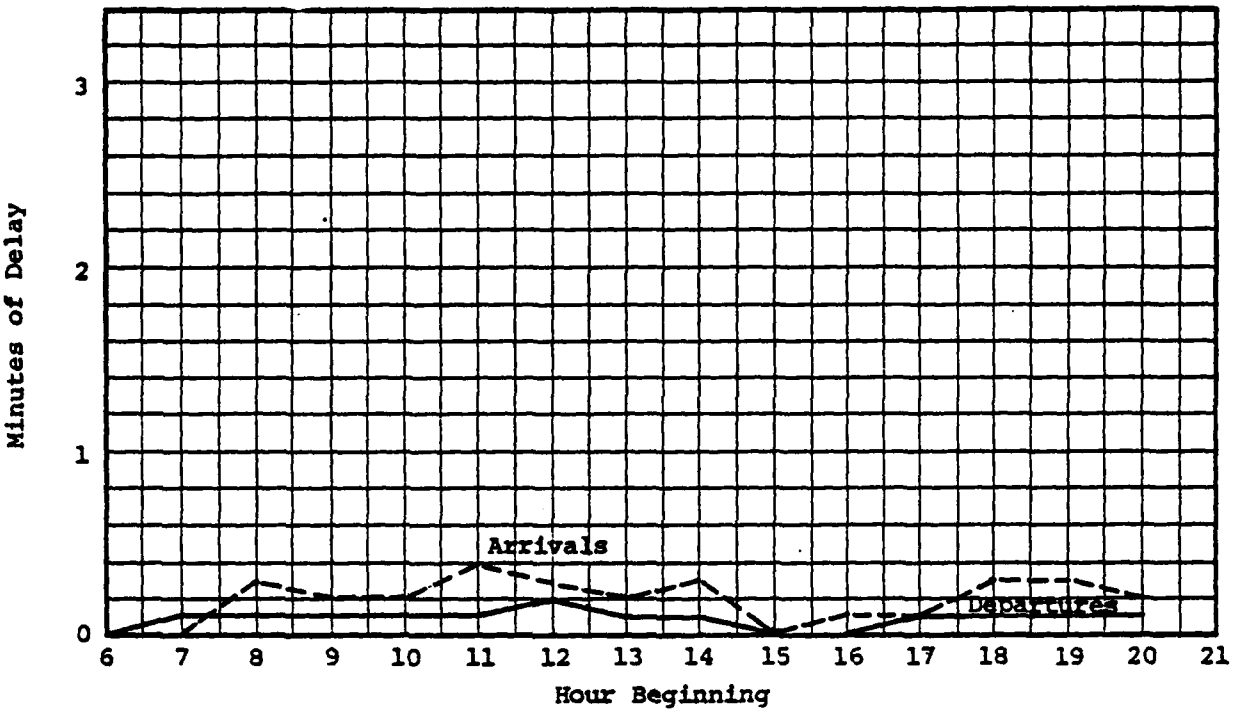
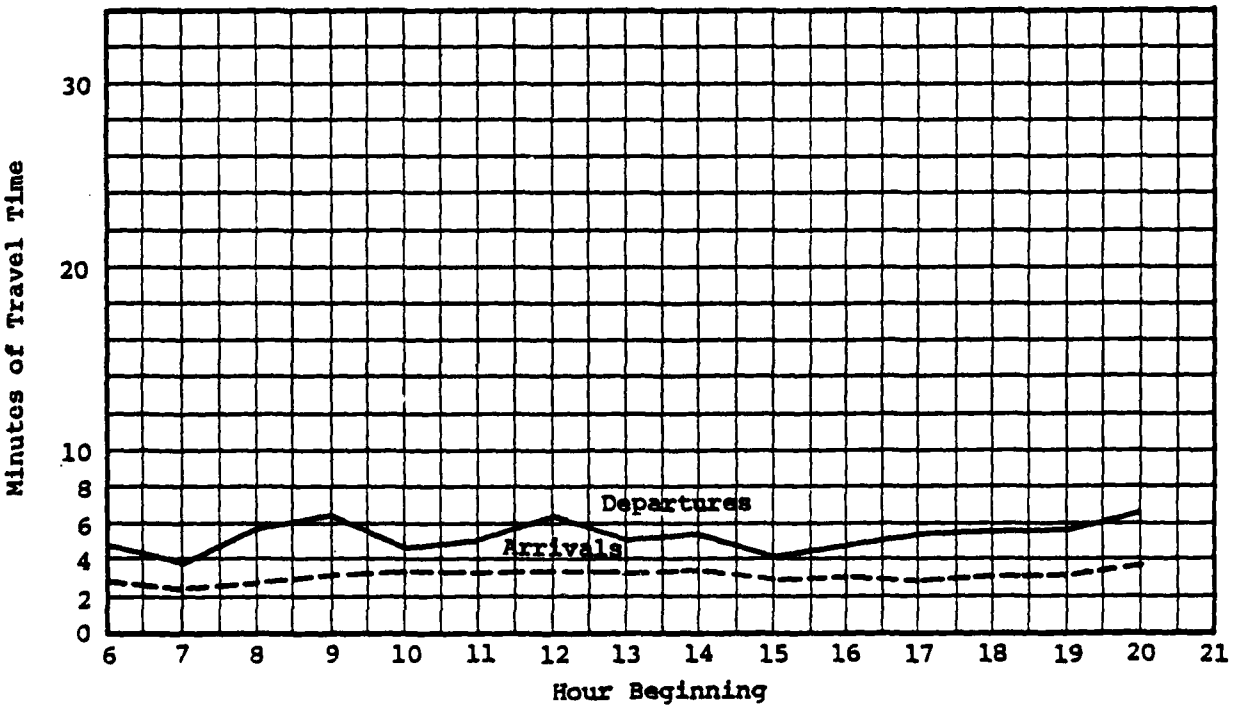


FIGURE 1D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 2

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR2 weather:

Arrival Runways	Departure Runways
28L, 28R, 1L	1L, 1R, 28L

Related Comparison Experiments:

Experiment No. 1 has the same runway use configuration, but in VFR1 weather.

Results:

Figure 2A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 2B shows that average delays to aircraft using the runways are as high as 4.3 minutes per aircraft. Peak hour average delays are 4.3 minutes for arrival aircraft and 3.3 minutes for departure aircraft.

Figure 2C shows that the peak-period average delays to aircraft using the taxiways are 0.2 minutes for taxi-in operations and 0.2 minutes for taxi-out operations.

Figure 2D shows that average aircraft taxi travel times vary from 2.3 to 7.2 minutes. Peak-hour average taxi travel times are 2.9 minutes for arrival aircraft and 7.2 minutes for departure aircraft.

FIGURE 2A AVERAGE RUNWAY FLOW RATES

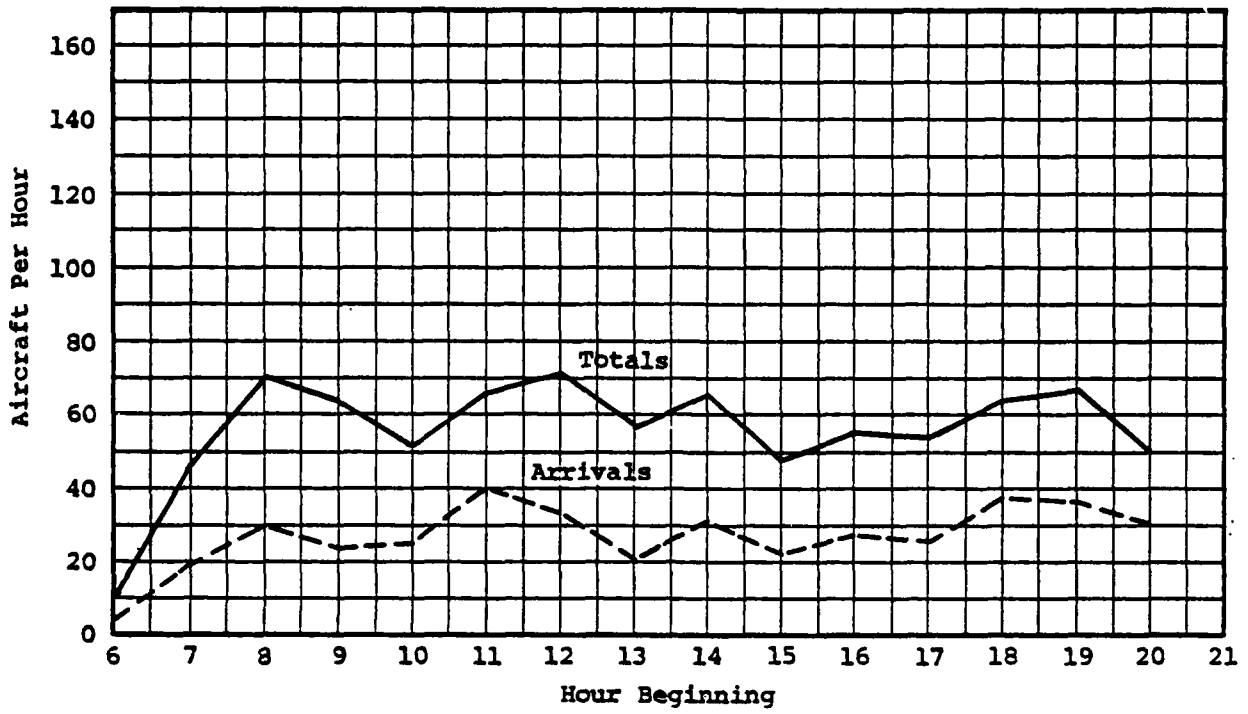


FIGURE 2B AVERAGE RUNWAY DELAYS

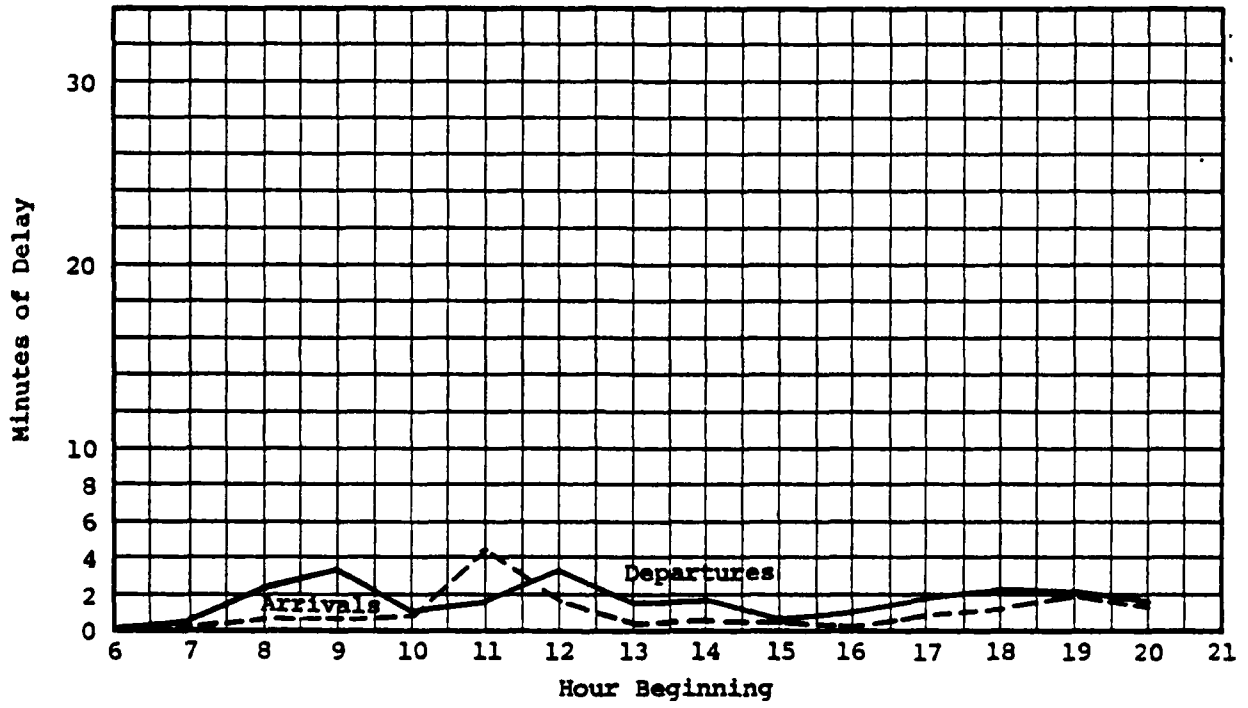


FIGURE 2C AVERAGE TAXIWAY DELAYS

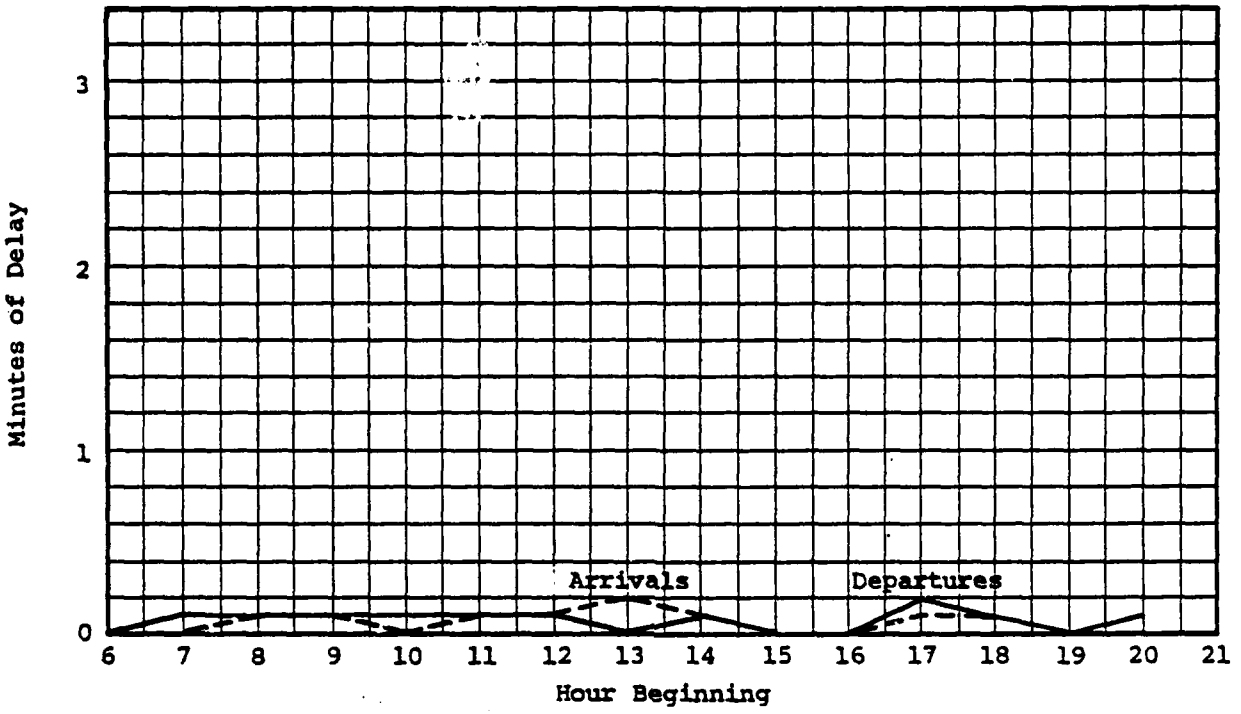
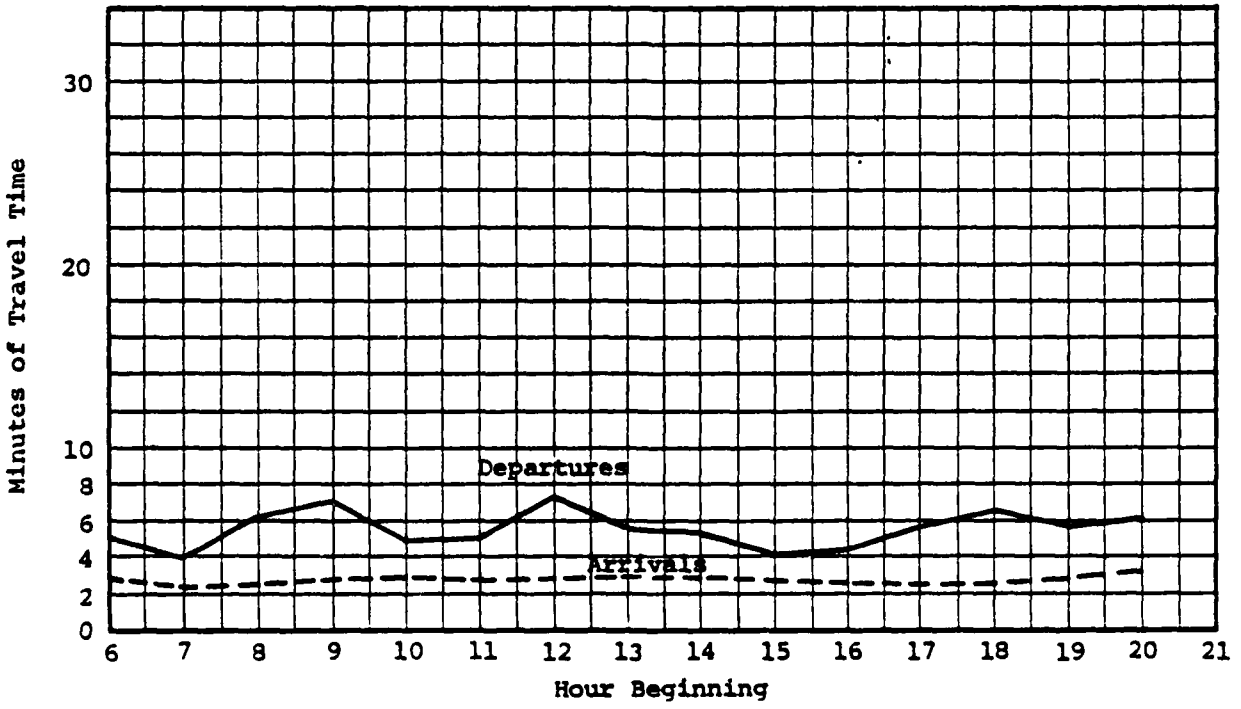


FIGURE 2D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 3

Objective:

To obtain 1977 baseline delay estimates for the following runway use in IFR1 weather:

Arrival Runways	Departure Runways
28R	1L, 1R, 28L

Related Comparison Experiments:

None directly in Stage I.

Results:

Figure 3A shows that total aircraft flows vary from 9 to 63 aircraft per hour over the 15 hour simulation run. The peak hour is from 900 to 1000 hours and contains 25 arrival aircraft and 38 departure aircraft.

Figure 3B shows that average delays to aircraft using the runways are as high as 114.7 minutes per aircraft. Peak hour average delays are 114.7 minutes for arrival aircraft and 1.2 minutes for departure aircraft.

Figure 3C shows that the peak-period average delays to aircraft using the taxiways are 0.0 minutes for taxi-in operations and 0.1 minutes for taxi-out operations.

Figure 3D shows that average aircraft taxi travel times vary from 3.1 to 5.0 minutes. Peak-hour average taxi travel times are 4.3 minutes for arrival aircraft and 5.0 minutes for departure aircraft.

FIGURE 3A AVERAGE RUNWAY FLOW RATES

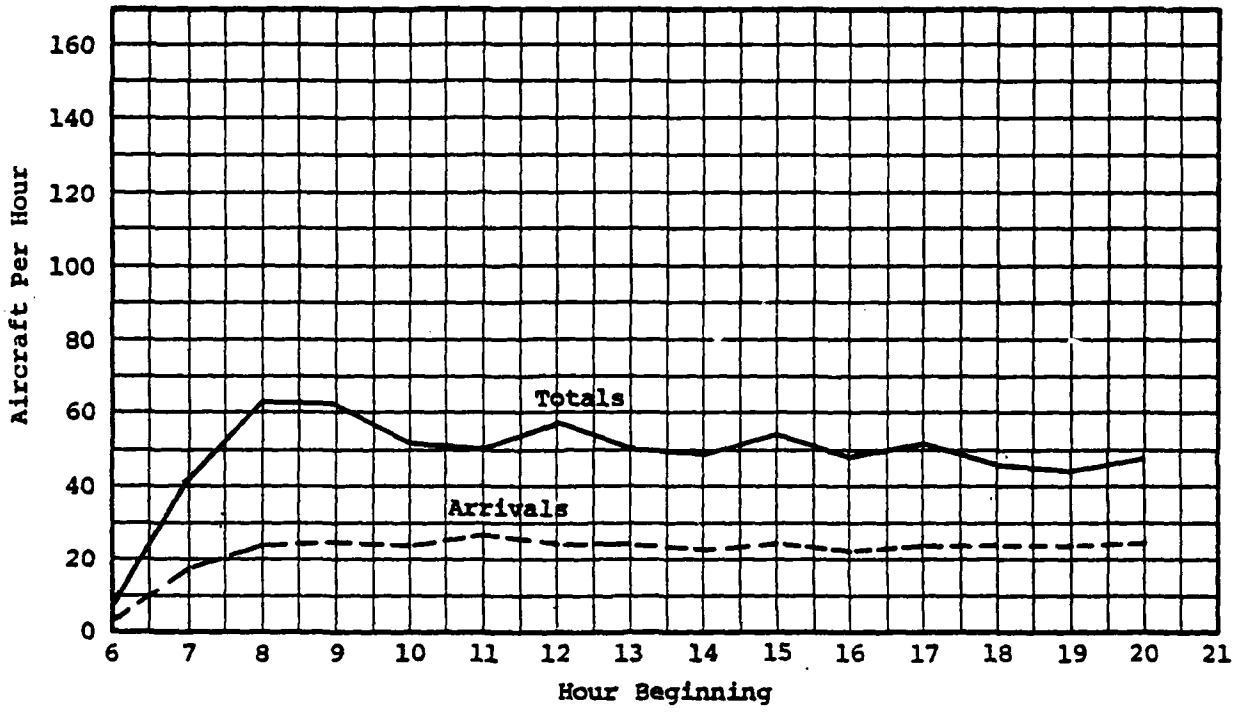


FIGURE 3B AVERAGE RUNWAY DELAYS

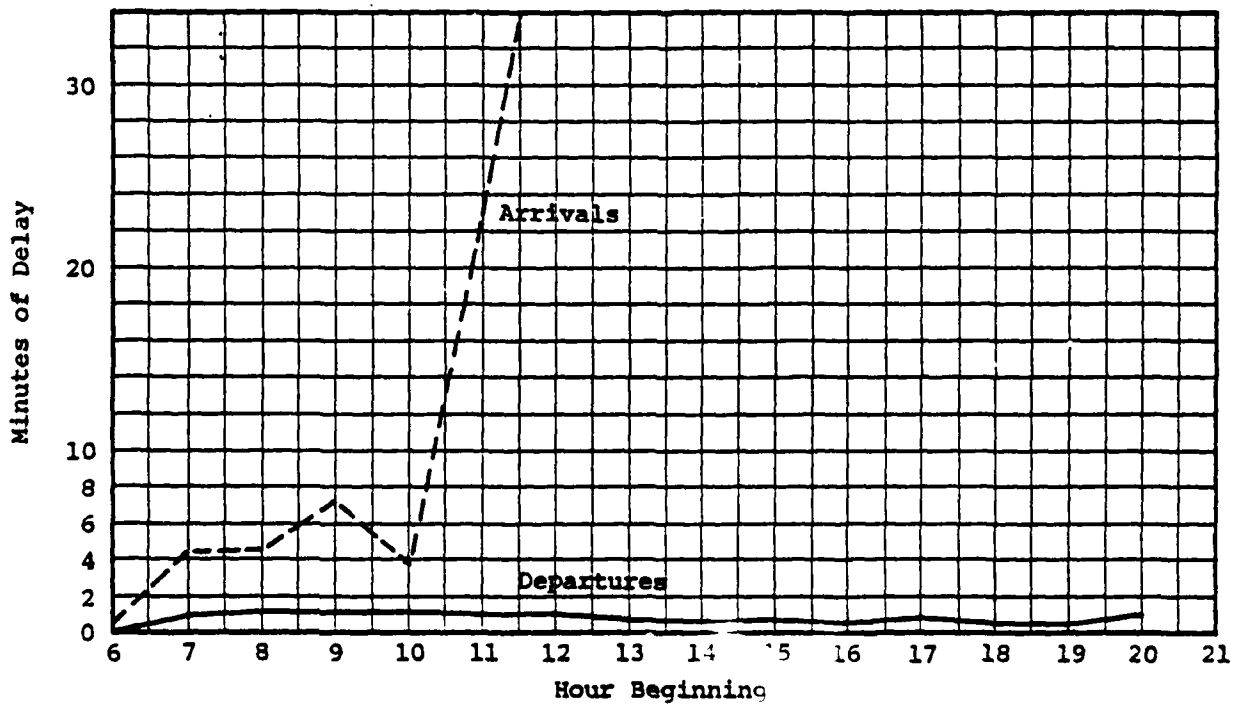


FIGURE 3C AVERAGE TAXIWAY DELAYS

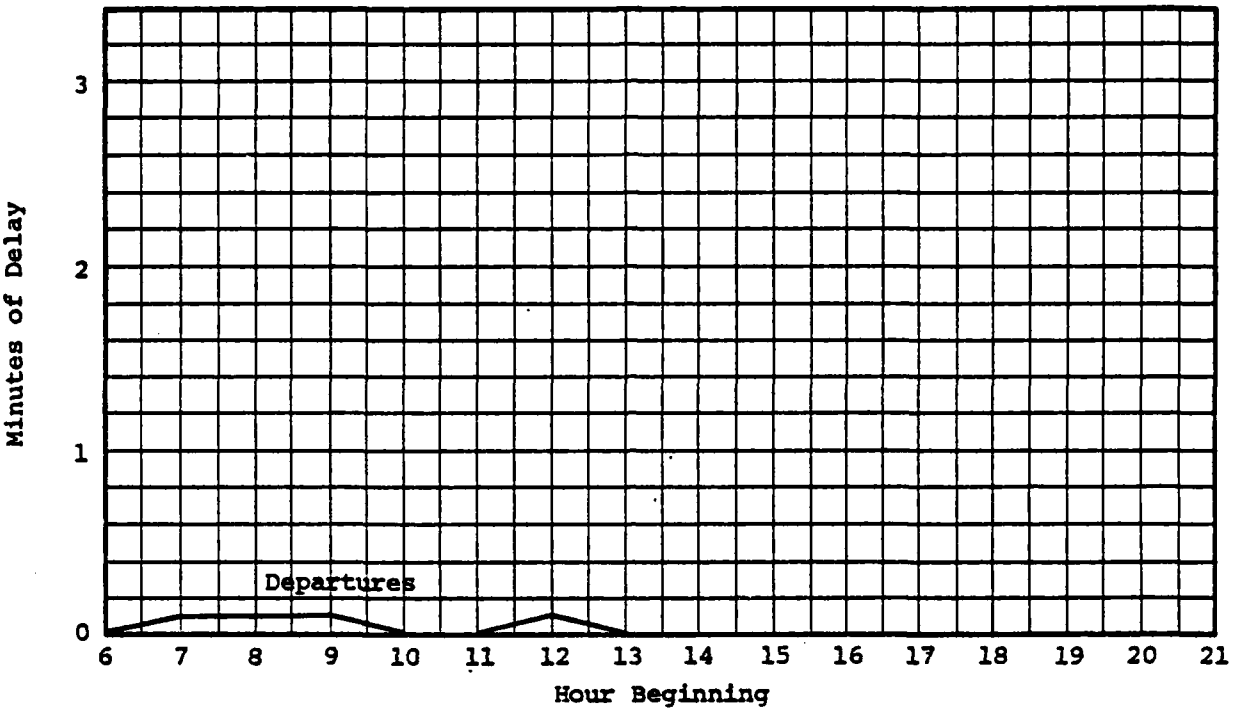
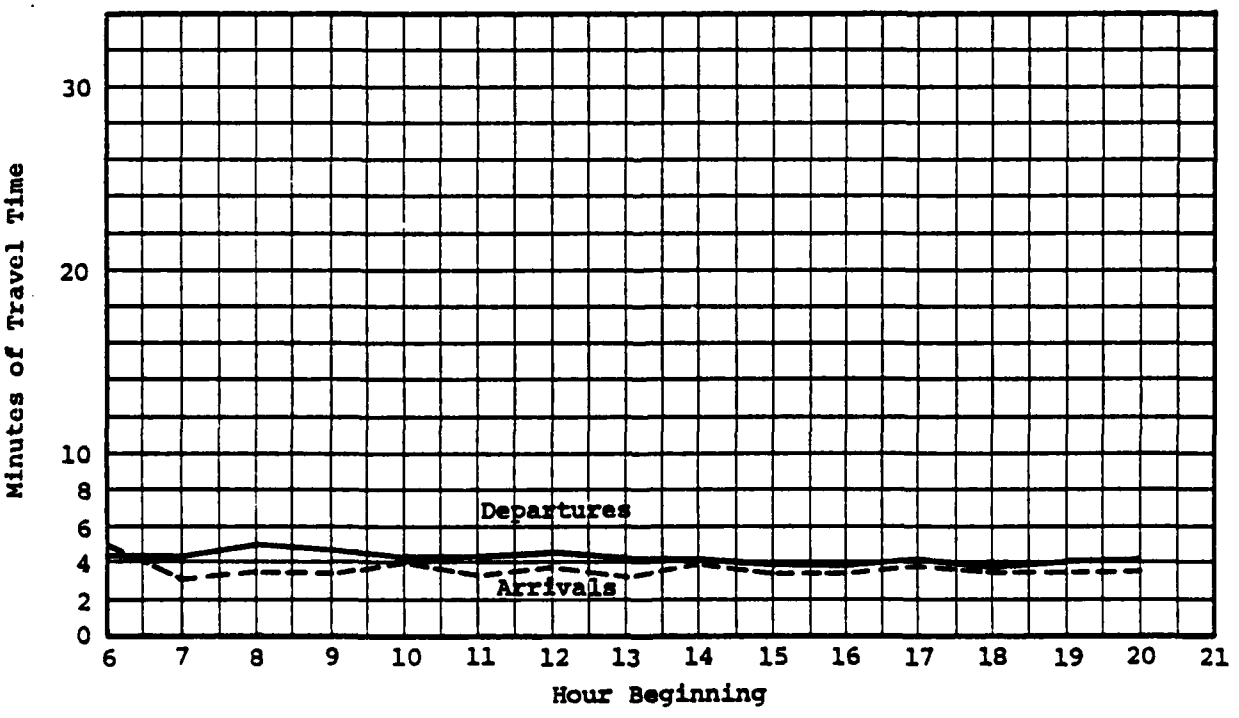


FIGURE 3D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 4

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR1 weather:

Arrival Runways	Departure Runways
28L, 28R	28L, 28R

Related Comparison Experiments:

None directly in Stage I.

Results:

Figure 4A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 4B shows that average delays to aircraft using the runways are as high as 5.4 minutes per aircraft. Peak hour average delays are 1.2 minutes for arrival aircraft and 5.4 minutes for departure aircraft.

Figure 4C shows that the peak-period average delays to aircraft using the taxiways are 0.4 minutes for taxi-in operations and 1.8 minutes for taxi-out operations.

Figure 4D shows that average aircraft taxi travel times vary from 2.7 to 11.7 minutes. Peak-hour average taxi travel times are 4.0 minutes for arrival aircraft and 11.7 minutes for departure aircraft.

FIGURE 4A AVERAGE RUNWAY FLOW RATES

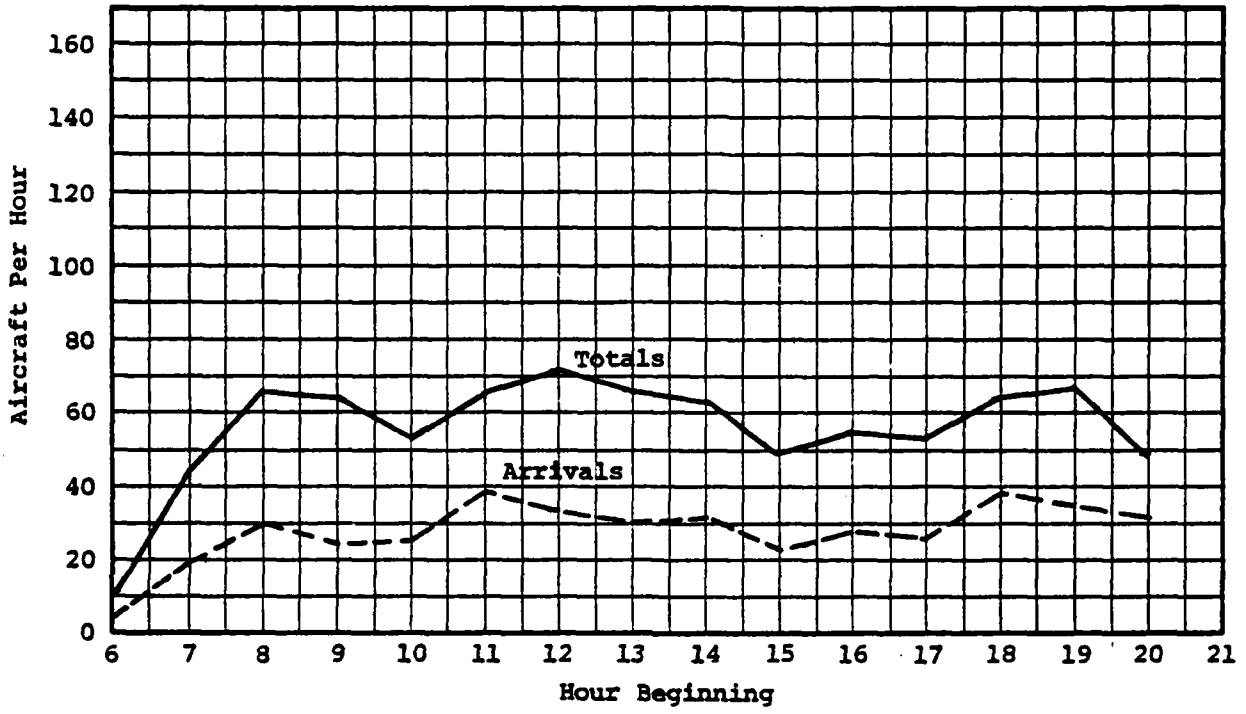


FIGURE 4B AVERAGE RUNWAY DELAYS

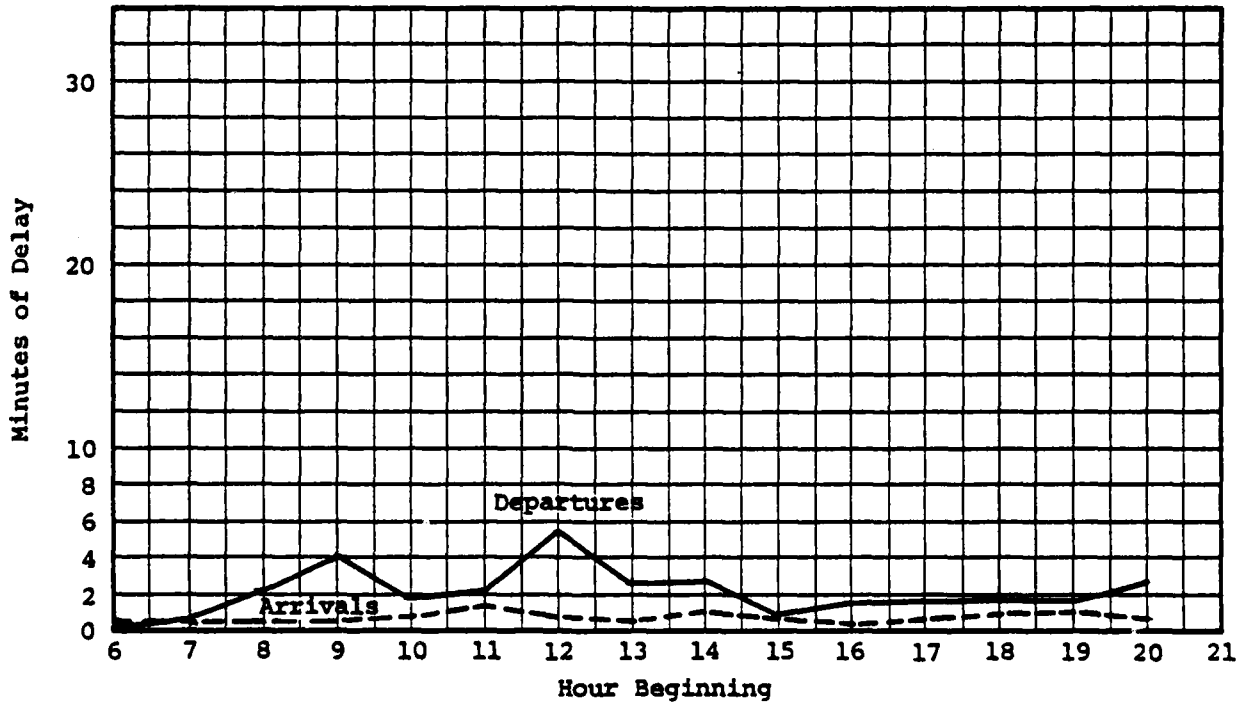


FIGURE 4C AVERAGE TAXIWAY DELAYS

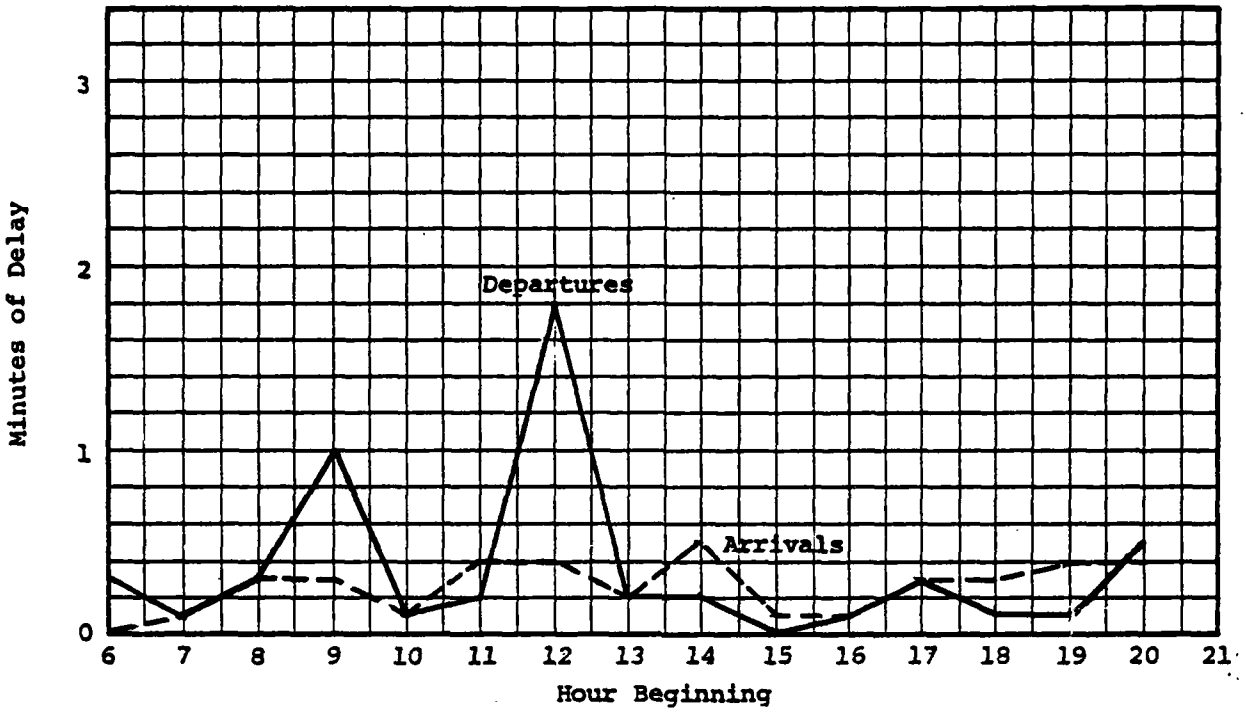
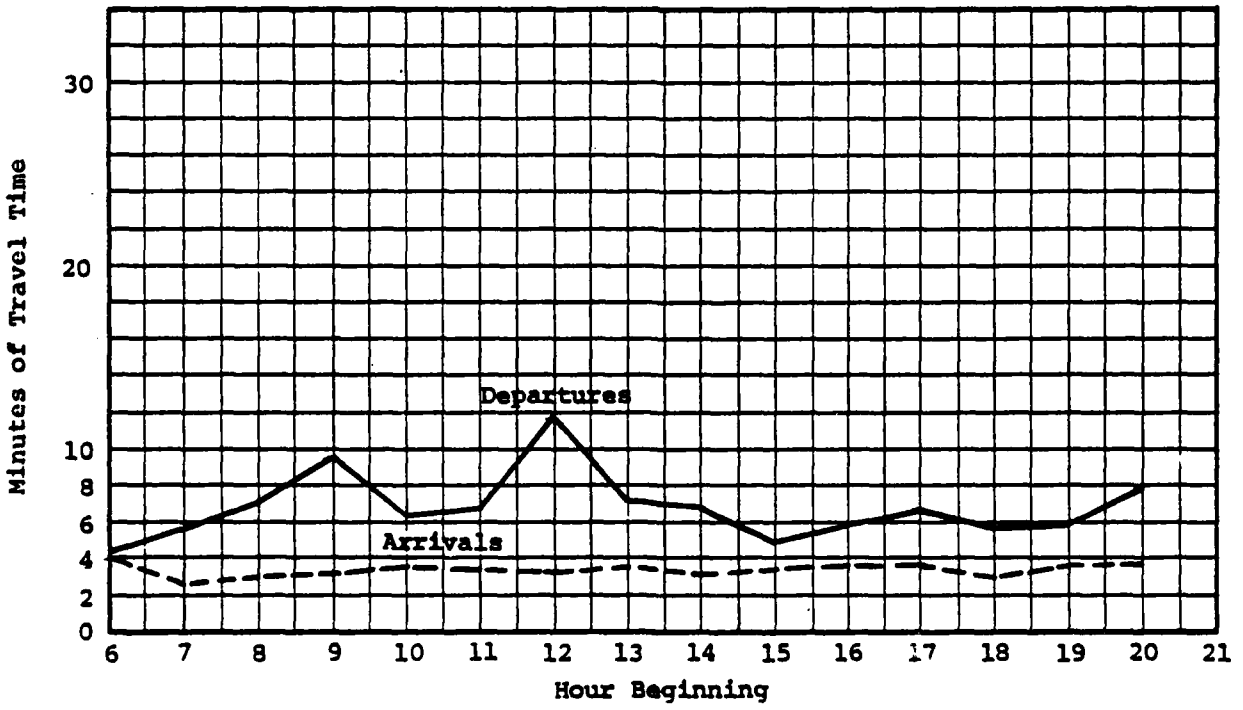


FIGURE 4D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 5

Objective:

To obtain 1977 baseline delay estimates for the following runway use in IRF1 weather:

Arrival Runways	Departure Runways
28R	28L

Related Comparison Experiments:

None directly in Stage I.

Results:

Figure 5A shows that total aircraft flows vary from 9 to 66 aircraft per hour over the 15 hour simulation run. The peak hour is from 0900 to 1000 hours and contains 26 arrival aircraft and 40 departure aircraft.

Figure 5B shows that average delays to aircraft using the runways are as high as 115.7 minutes per aircraft. Peak hour average delays are 115.7 minutes for arrival aircraft and 4.4 minutes for departure aircraft.

Figure 5C shows that the peak-period average delays to aircraft using the taxiways are 0.1 minutes for taxi-in operations and 0.1 minutes for taxi-out operations.

Figure 5D shows that average aircraft taxi travel times vary from 3.9 to 10.1 minutes. Peak-hour average taxi travel times are 5.2 minutes for arrival aircraft and 10.1 minutes for departure aircraft.

FIGURE 5A AVERAGE RUNWAY FLOW RATES

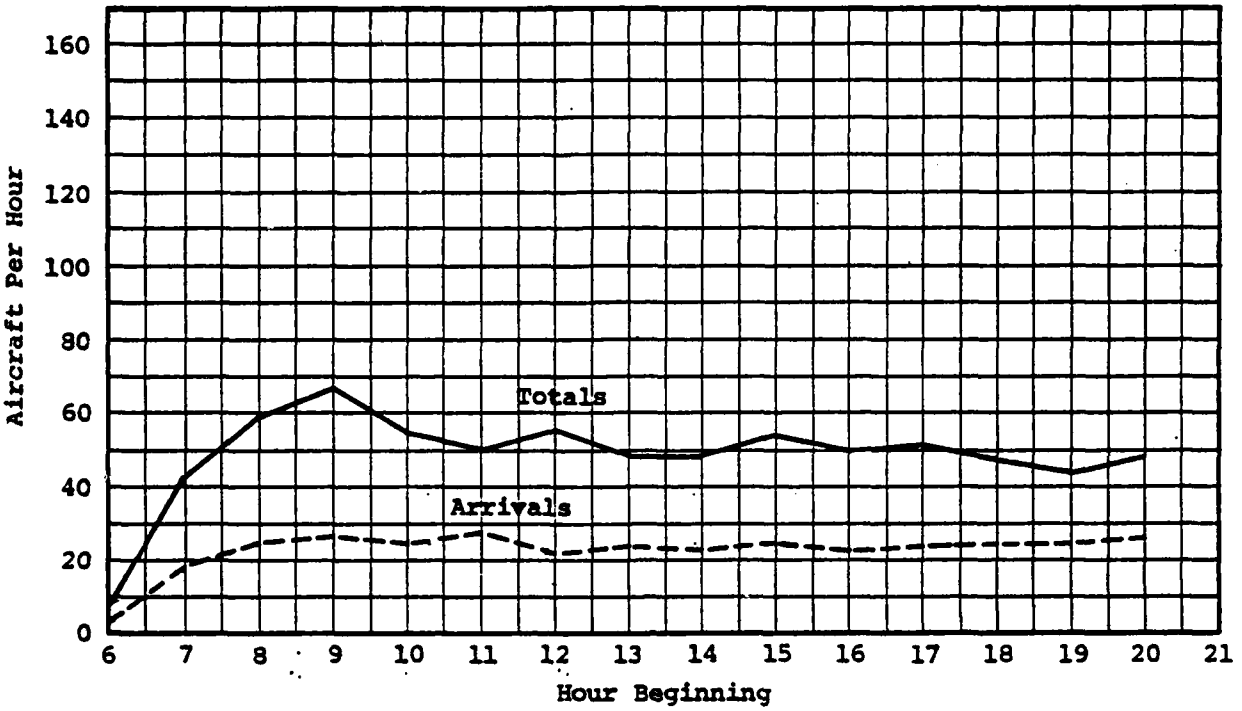


FIGURE 5B AVERAGE RUNWAY DELAYS

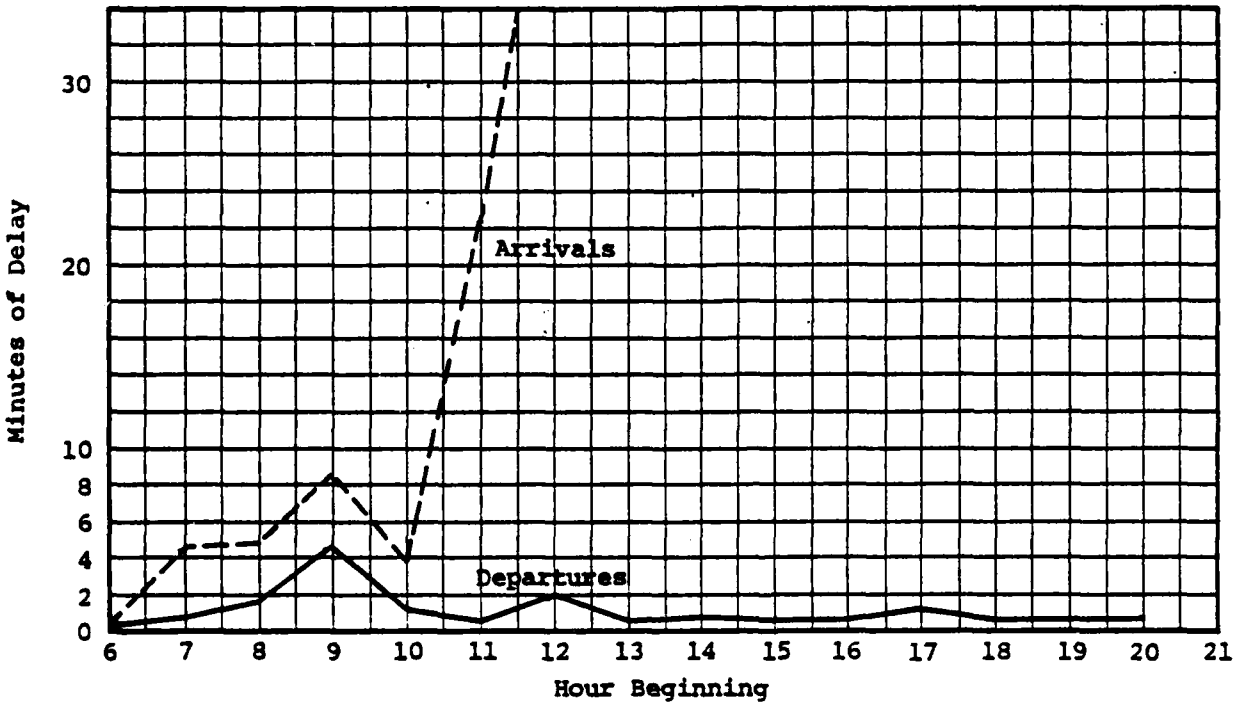


FIGURE 5C AVERAGE TAXIWAY DELAYS

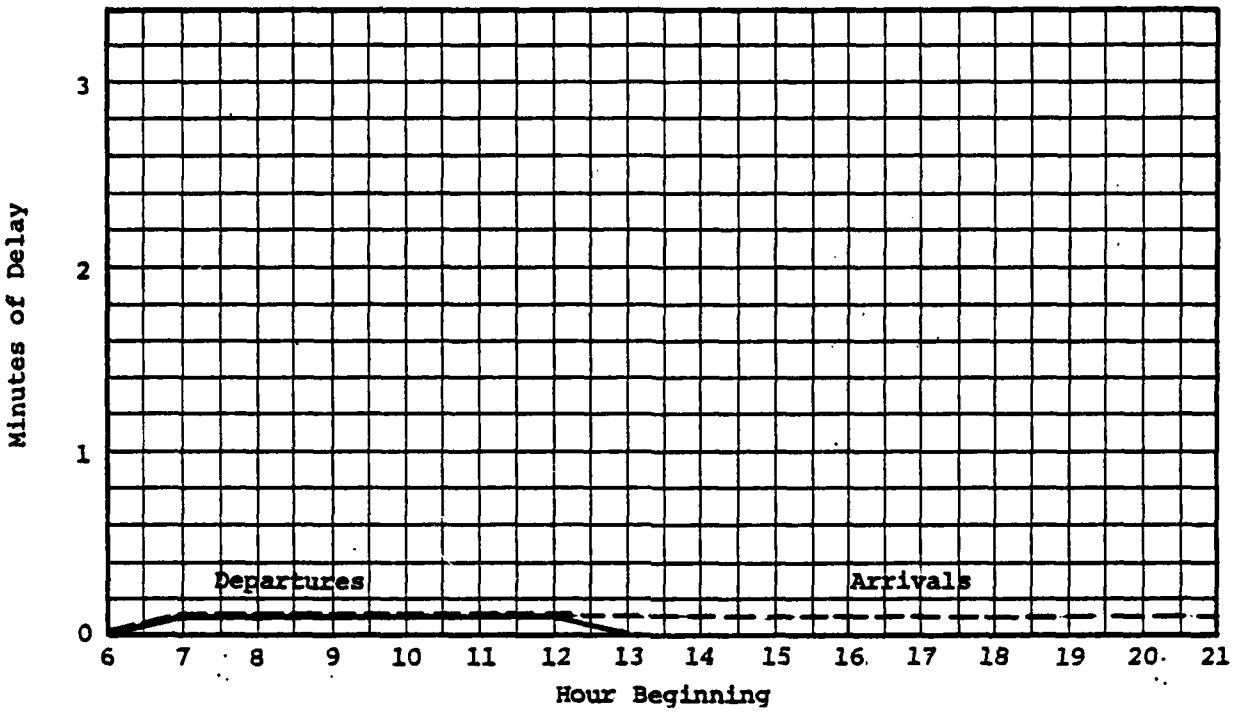
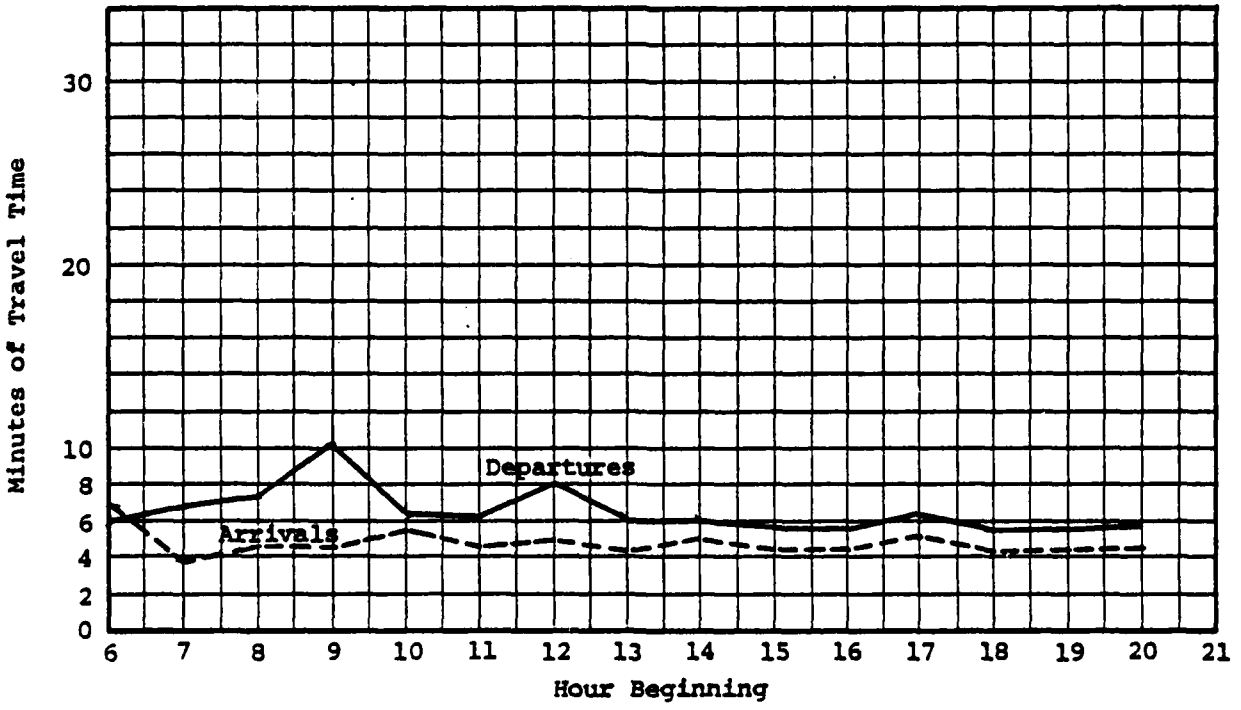


FIGURE 5D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 6

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR1 weather:

Arrival Runways	Departure Runways
19L, 19R	10L, 10R, 19R

Related Comparison Experiments:

Experiment 11 estimates the impact of the extension of Runway 1L/19R with VASI on 19R. Experiment 12 estimates the impact of the extension of Taxiway K with simultaneous departures on the 10's.

Results:

Figure 6A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 6B shows that average delays to aircraft using the runways are as high as 5.9 minutes per aircraft. Peak hour average delays are 2.5 minutes for arrival aircraft and 5.9 minutes for departure aircraft.

Figure 6C shows that the peak-period average delays to aircraft using the taxiways are 0.5 minutes for taxi-in operations and 1.7 minutes for taxi-out operations.

Figure 6D shows that average aircraft taxi travel times vary from 2.4 to 11.0 minutes. Peak-hour average taxi travel times are 3.8 minutes for arrival aircraft and 11.0 minutes for departure aircraft.

FIGURE 6A AVERAGE RUNWAY FLOW RATES

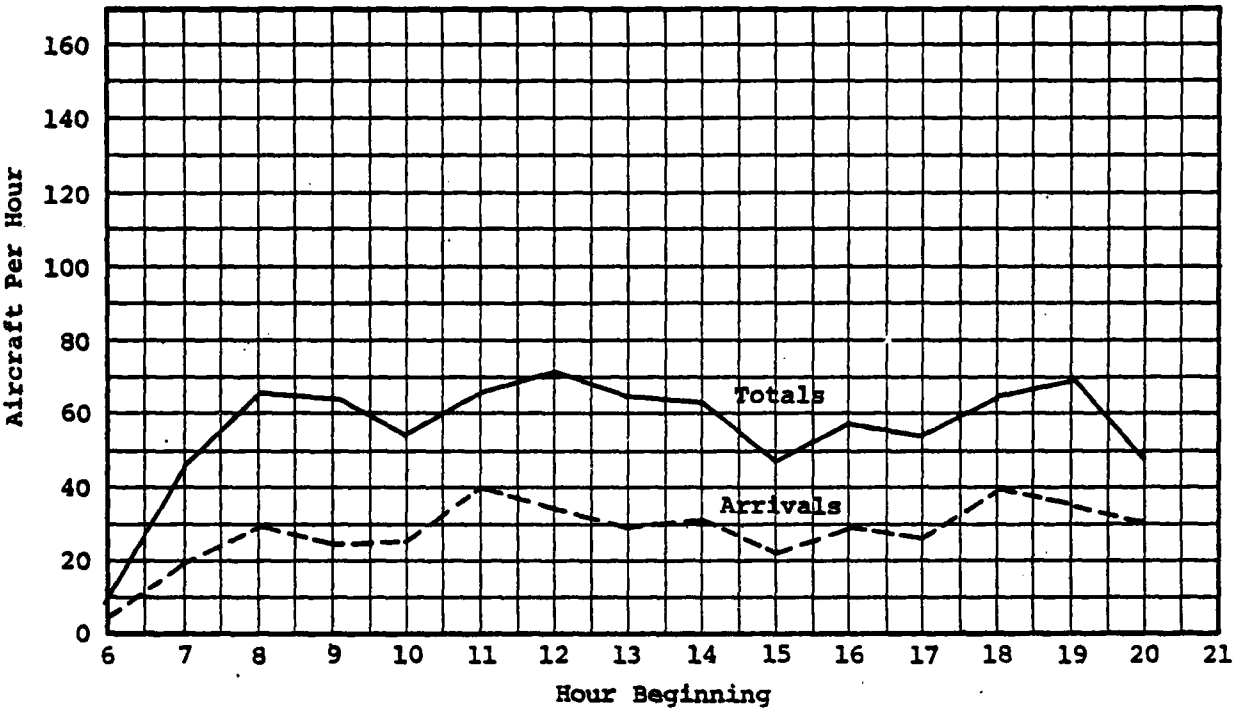


FIGURE 6B AVERAGE RUNWAY DELAYS

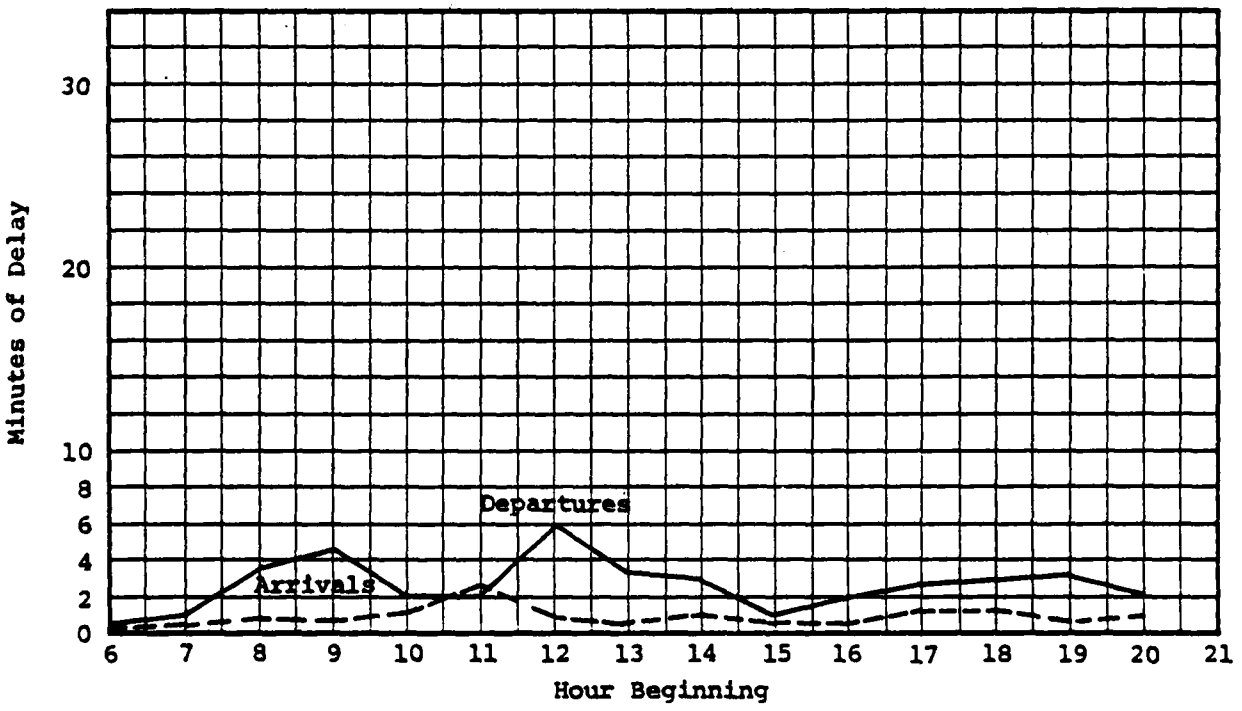


FIGURE 6C AVERAGE TAXIWAY DELAYS

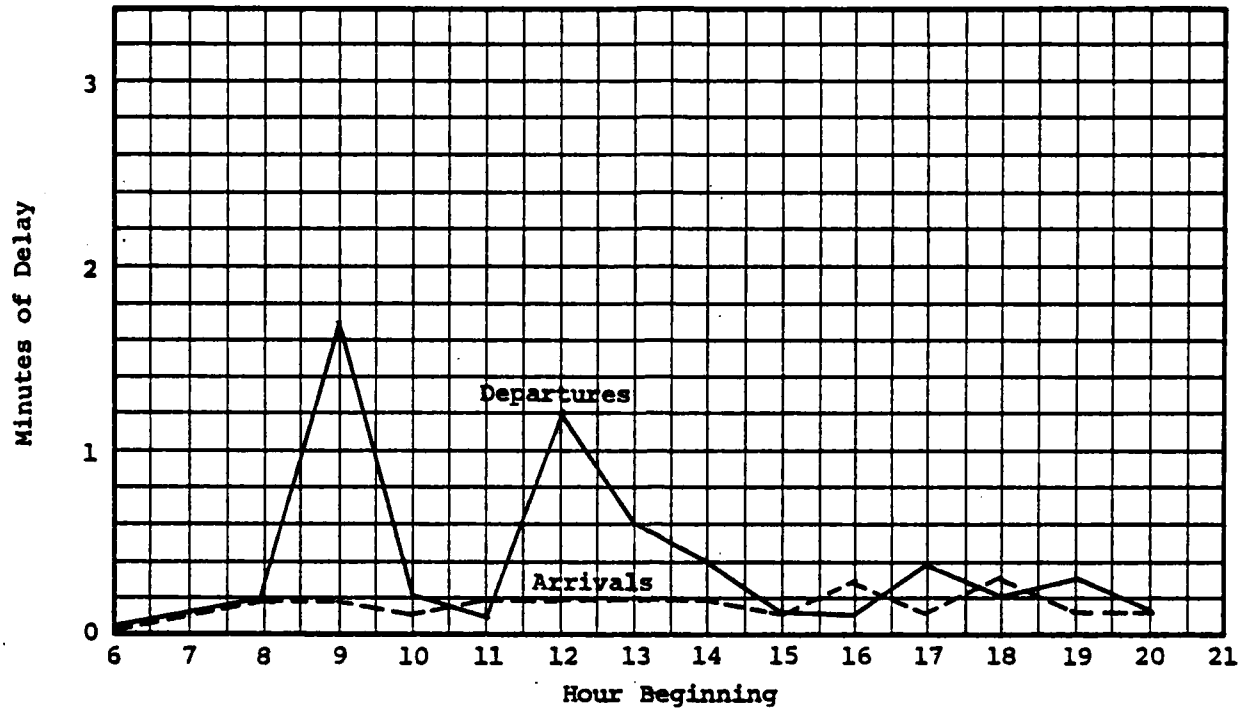
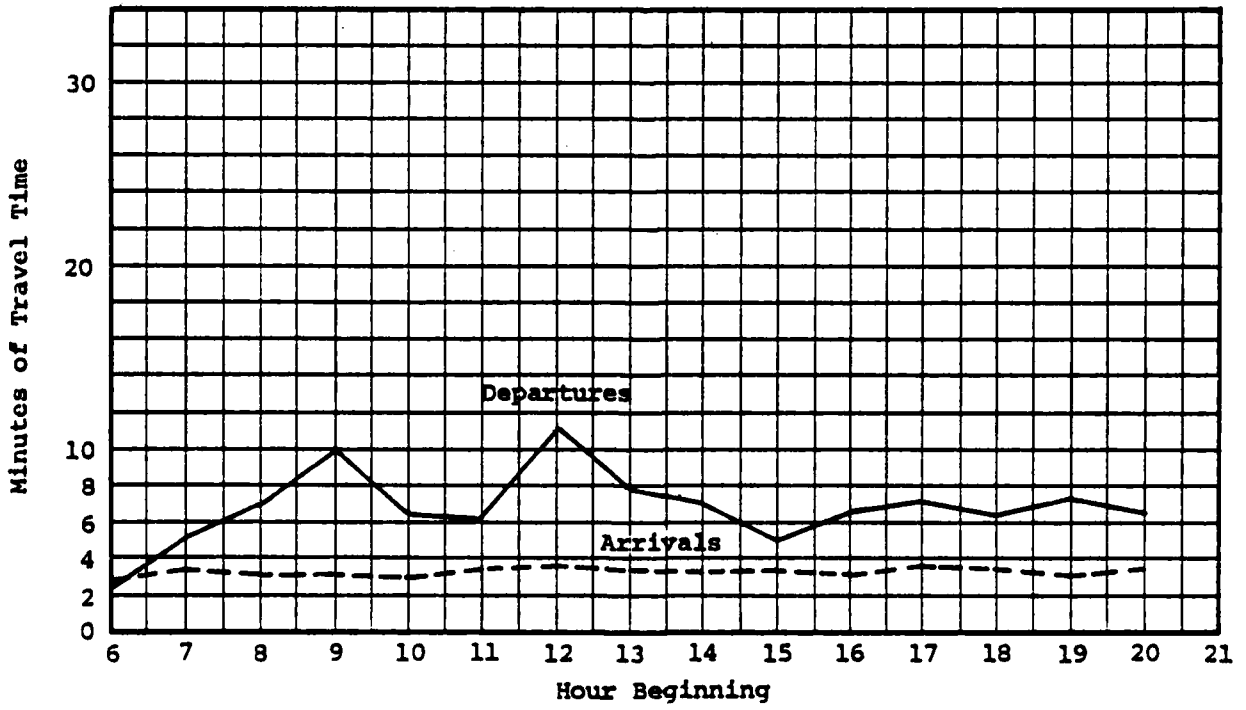


FIGURE 6D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 7

Objective:

To obtain 1977 baseline delay estimates for the following runway use in IFR1 weather:

Arrival Runways	Departure Runways
19L	10L, 10R

Related Comparison Experiments:

None directly in Stage I.

Results:

Figure 7A shows that total aircraft flows vary from 9 to 50 aircraft per hour over the 7 hour simulation run. The peak hour is from 1100 to 1200 hours and contains 26 arrival aircraft and 24 departure aircraft.

Figure 7B shows that average delays to aircraft using the runways are as high as 80.5 minutes per aircraft. Peak hour average delays are 45.6 minutes for arrival aircraft and 80.5 minutes for departure aircraft.

Figure 7C shows that the peak-period average delays to aircraft using the taxiways are 48.7 minutes for taxi-in operations and 28.0 minutes for taxi-out operations.

Figure 7D shows that average aircraft taxi travel times vary from 2.3 to 85.8 minutes. Peak-hour average taxi travel times are 50.7 minutes for arrival aircraft and 85.8 minutes for departure aircraft.

FIGURE 7A AVERAGE RUNWAY FLOW RATES

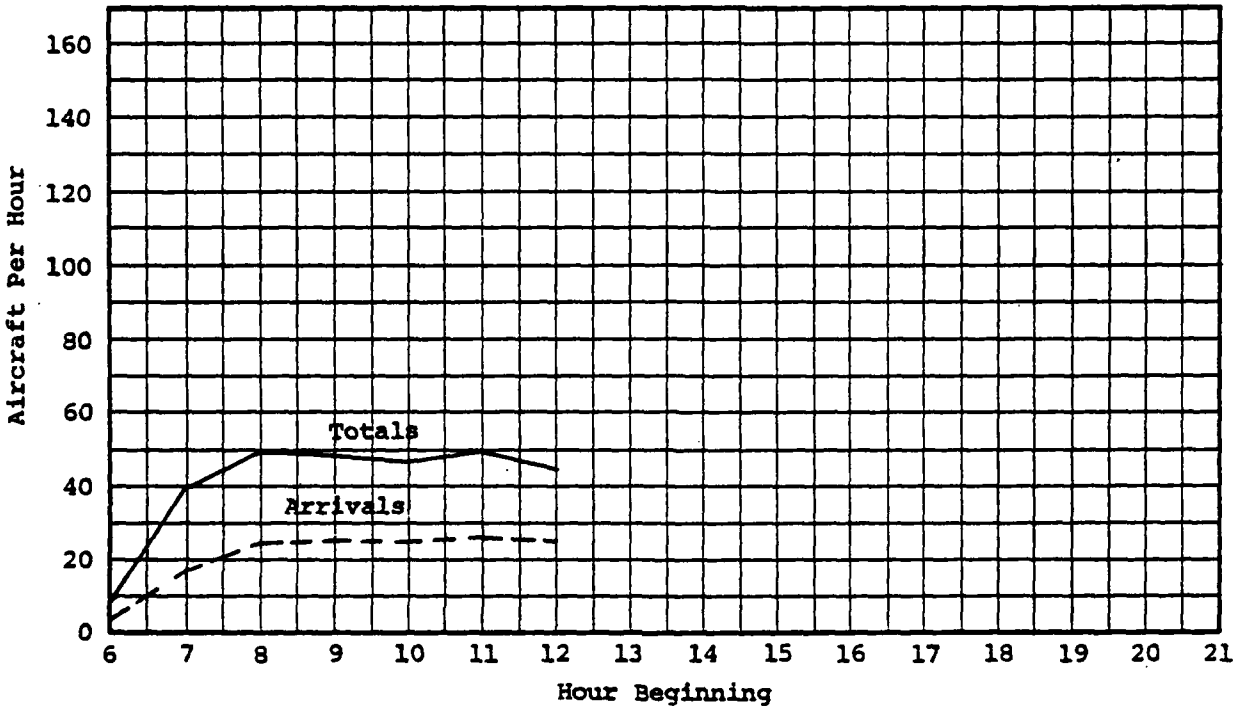


FIGURE 7B AVERAGE RUNWAY DELAYS

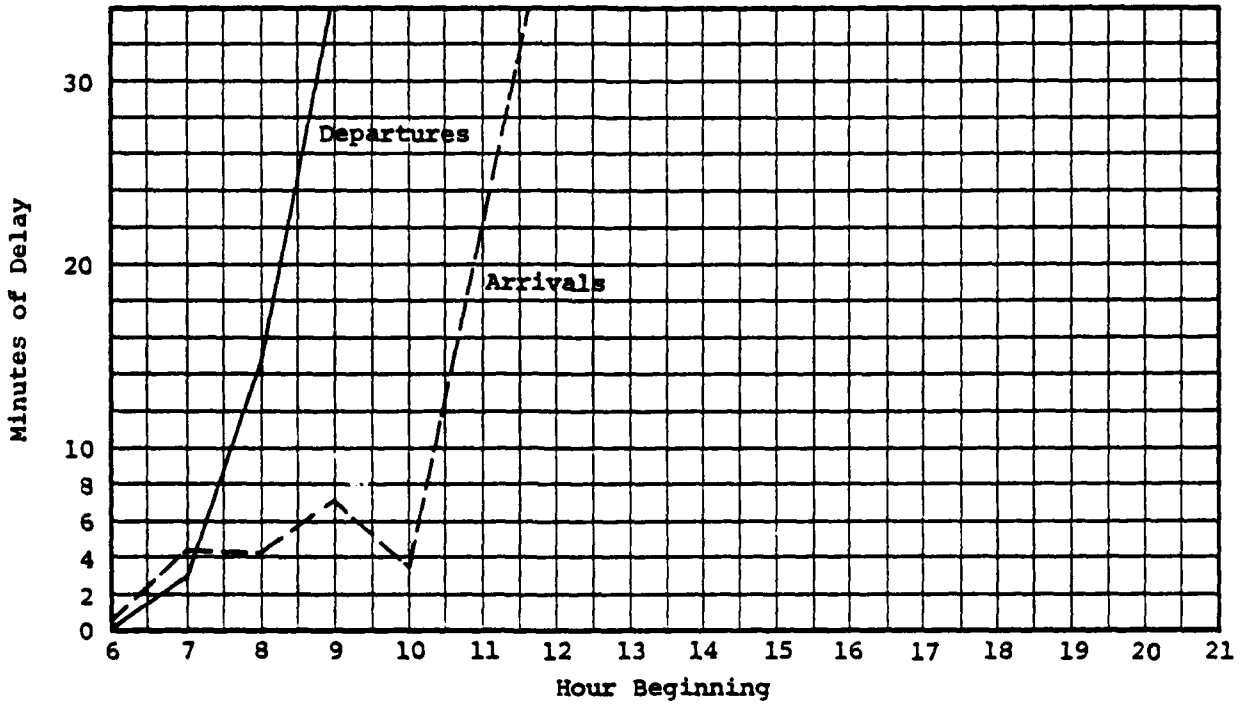


FIGURE 7C AVERAGE TAXIWAY DELAYS

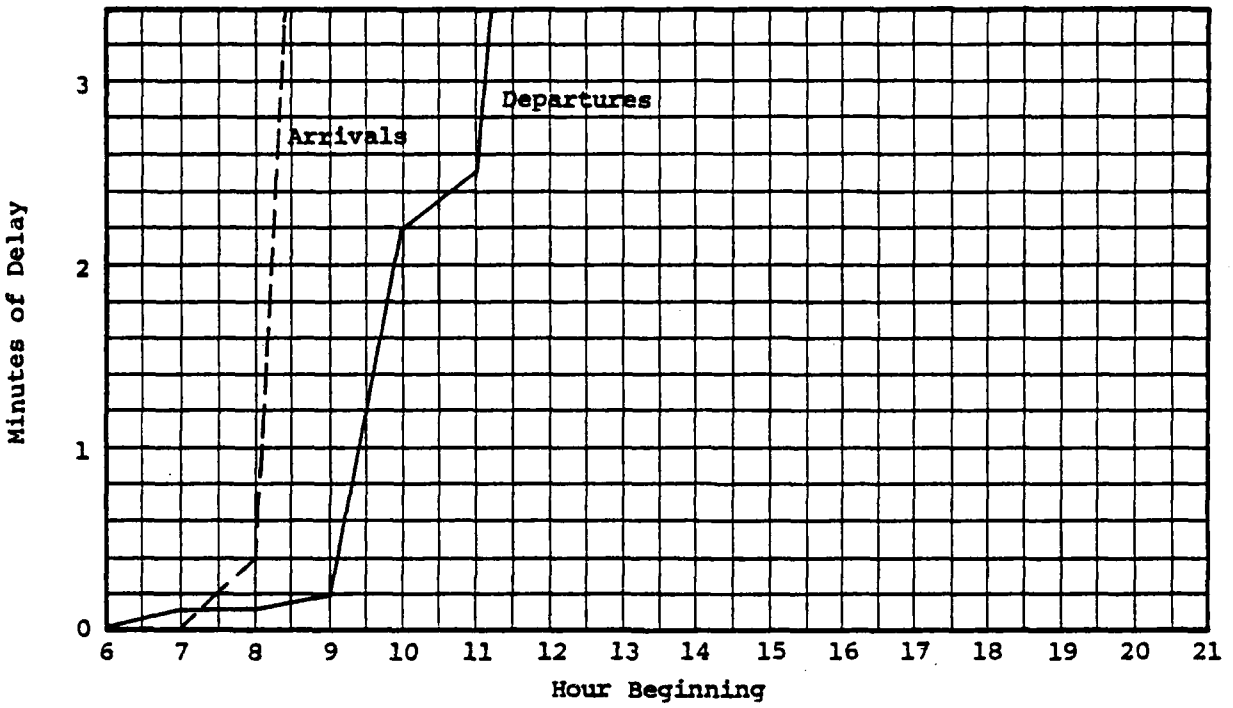
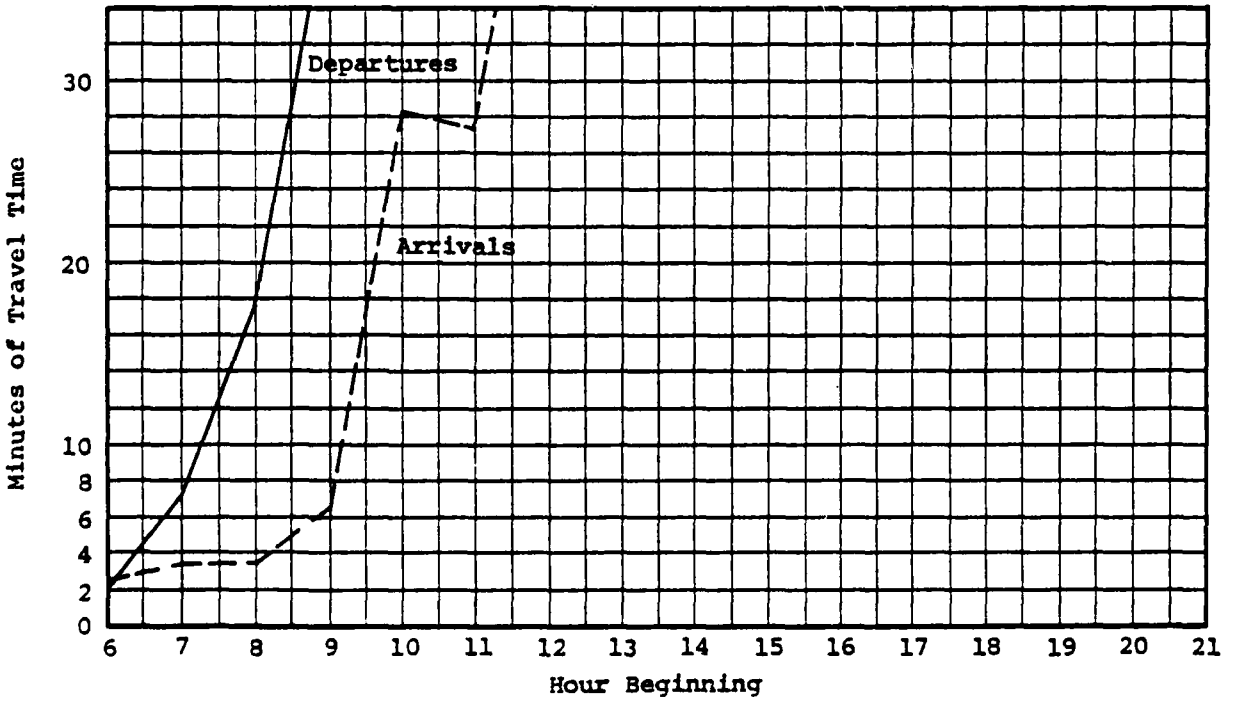


FIGURE 7D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 8

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR2 weather:

Arrival Runways	Departure Runways
19L, 19R	19L, 19R

Related Comparison Experiments:

None directly in Stage I.

Results:

Figure 8A shows that total aircraft flows vary from 11 to 70 aircraft per hour over the 15 hour simulation run. The peak hour is from 1400 to 1500 hours and contains 31 arrival aircraft and 39 departure aircraft.

Figure 8B shows that average delays to aircraft using the runways are as high as 21.7 minutes per aircraft. Peak hour average delays are 4.2 minutes for arrival aircraft and 21.7 minutes for departure aircraft.

Figure 8C shows that the peak-period average delays to aircraft using the taxiways are 0.2 minutes for taxi-in operations and 1.9 minutes for taxi-out operations.

Figure 8D shows that average aircraft taxi travel times vary from 2.8 to 28.5 minutes. Peak-hour average taxi travel times are 3.9 minutes for arrival aircraft and 28.5 minutes for departure aircraft.

FIGURE 8A AVERAGE RUNWAY FLOW RATES

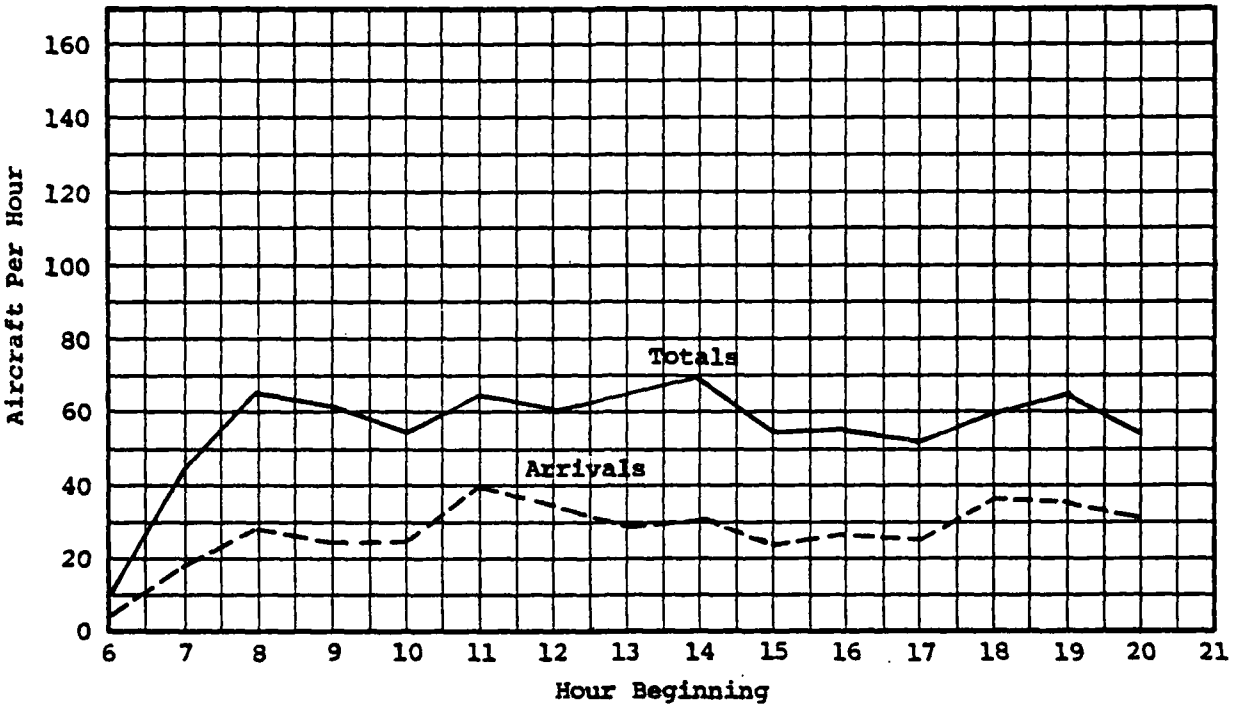


FIGURE 8B AVERAGE RUNWAY DELAYS

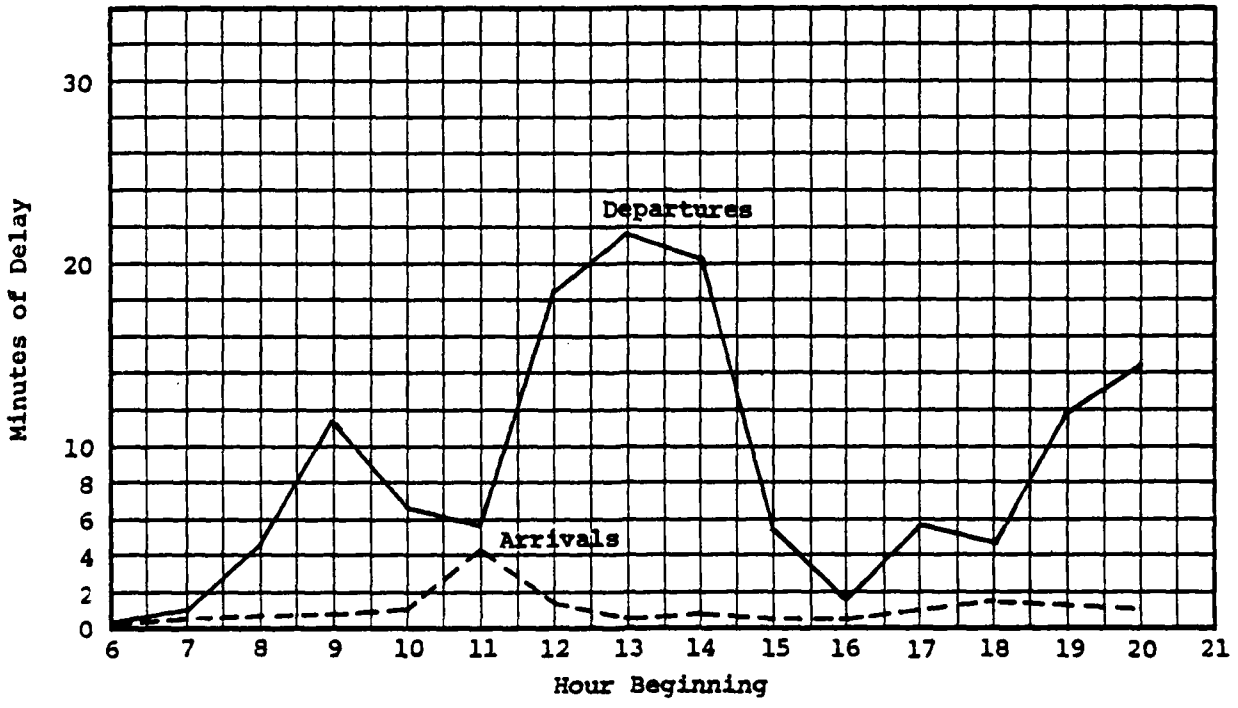


FIGURE 8C AVERAGE TAXIWAY DELAYS

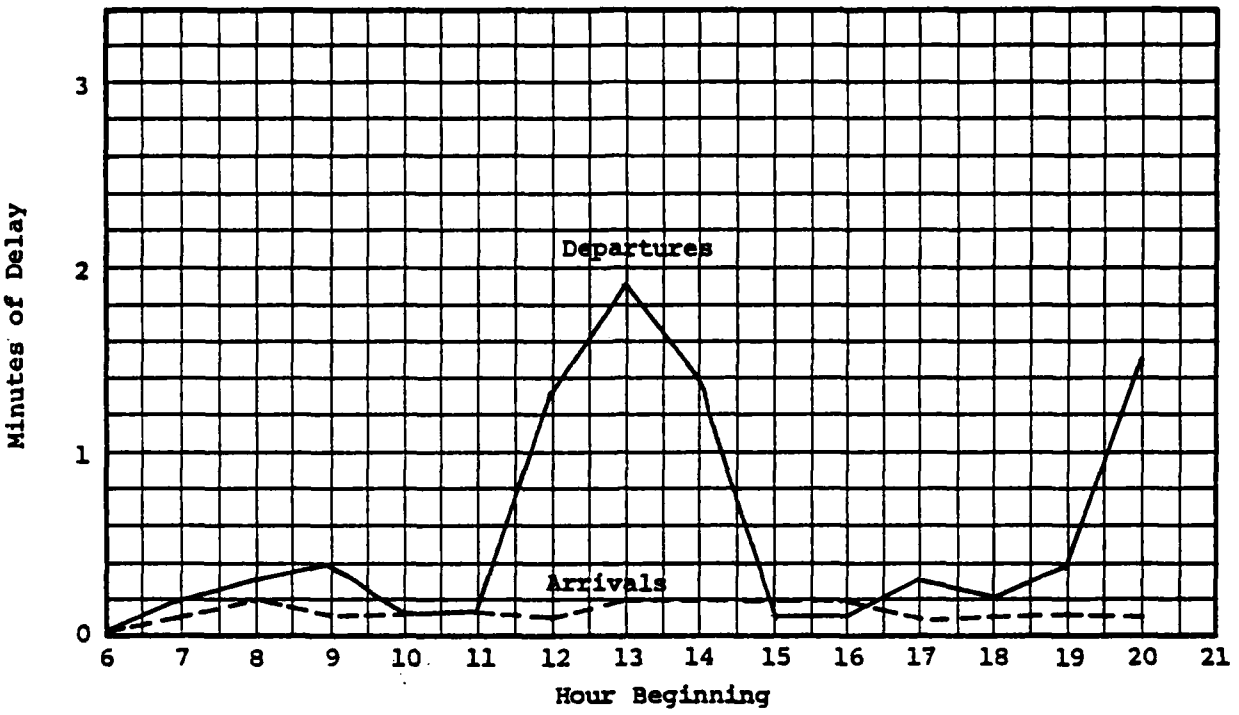
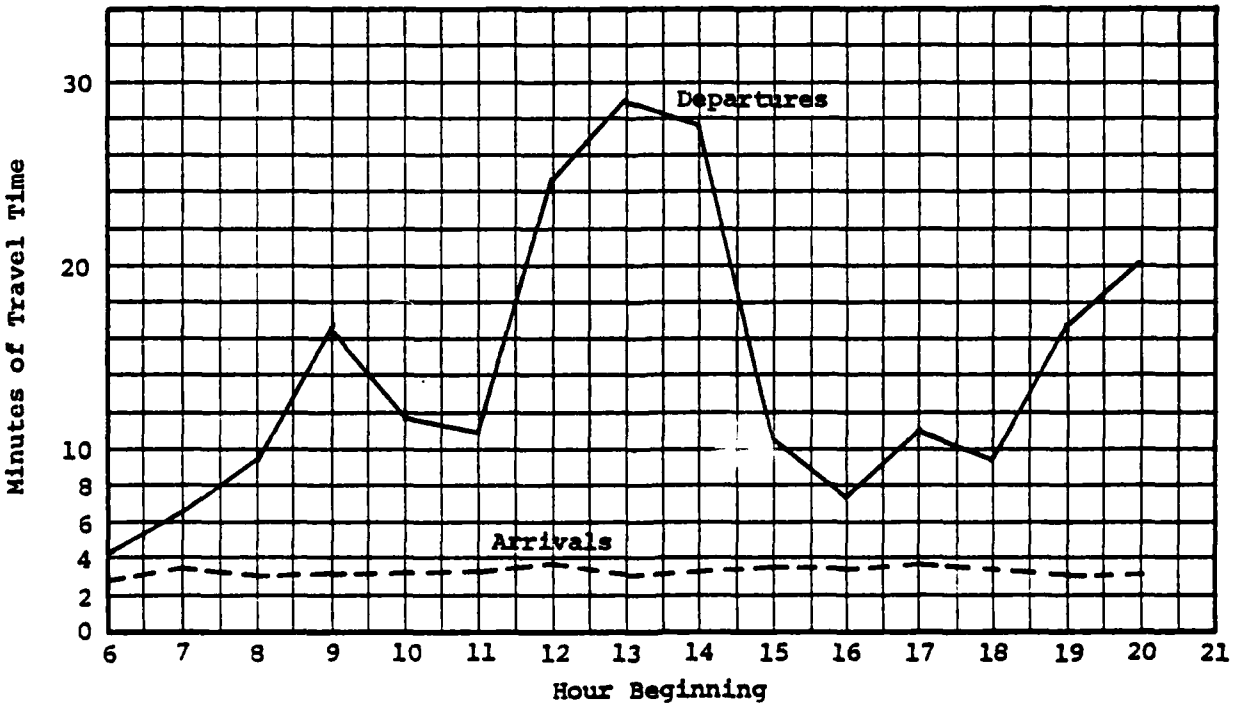


FIGURE 8D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 9

Objective:

To obtain 1977 baseline delay estimates for the following runway use in IFR2 weather:

Arrival Runways	Departure Runways
19L	19L, 19R

Related Comparison Experiments:

Experiment 10 estimates the impact of extending Taxiways L and V.

Results:

Figure 9A shows that total aircraft flows vary from 9 to 39 aircraft per hour over the 7 hour simulation run. The peak hour is from 0900 to 1000 hours and contains 19 arrival aircraft and 20 departure aircraft.

Figure 9B shows that average delays to aircraft using the runways are as high as 120.2 minutes per aircraft. Peak hour average delays are 36.7 minutes for arrival aircraft and 120.2 minutes for departure aircraft.

Figure 9C shows that the peak-period average delays to aircraft using the taxiways are 90.0 minutes for taxi-in operations and 13.6 minutes for taxi-out operations.

Figure 9D shows that average aircraft taxi travel times vary from 2.4 to 138.6 minutes. Peak-hour average taxi travel times are 77.5 minutes for arrival aircraft and 138.6 minutes for departure aircraft.

FIGURE 9A AVERAGE RUNWAY FLOW RATES

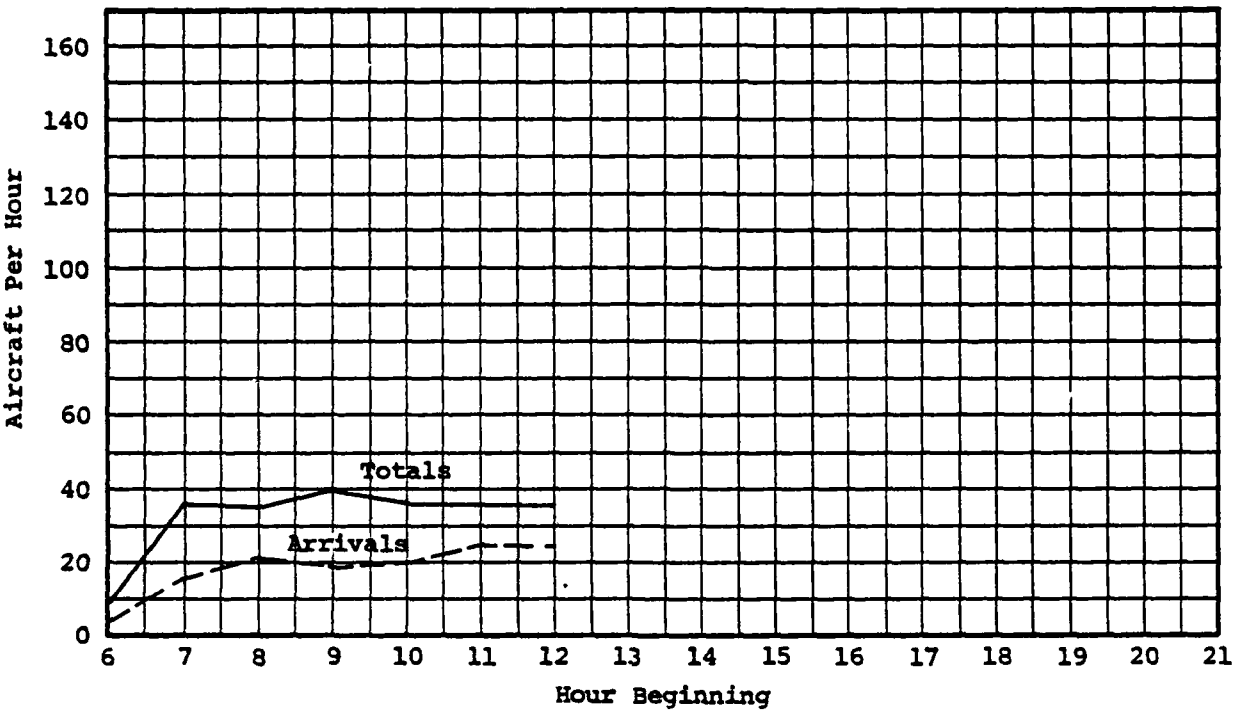


FIGURE 9B AVERAGE RUNWAY DELAYS

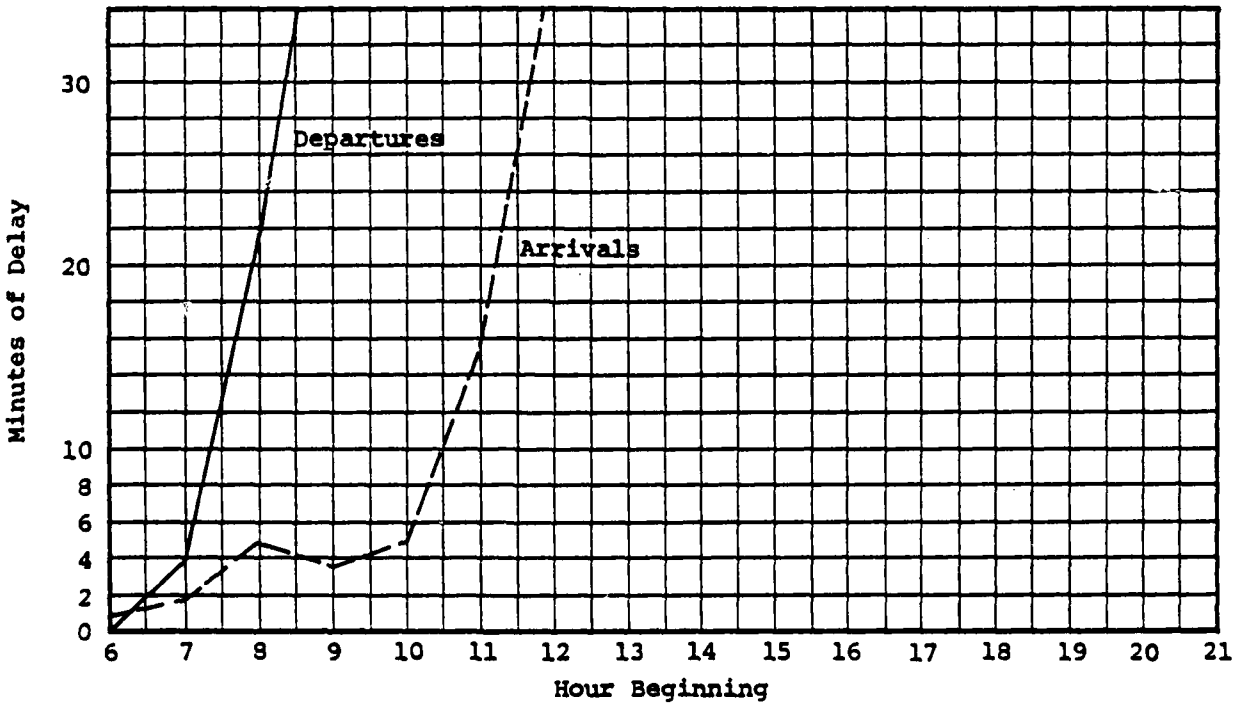


FIGURE 9C AVERAGE TAXIWAY DELAYS

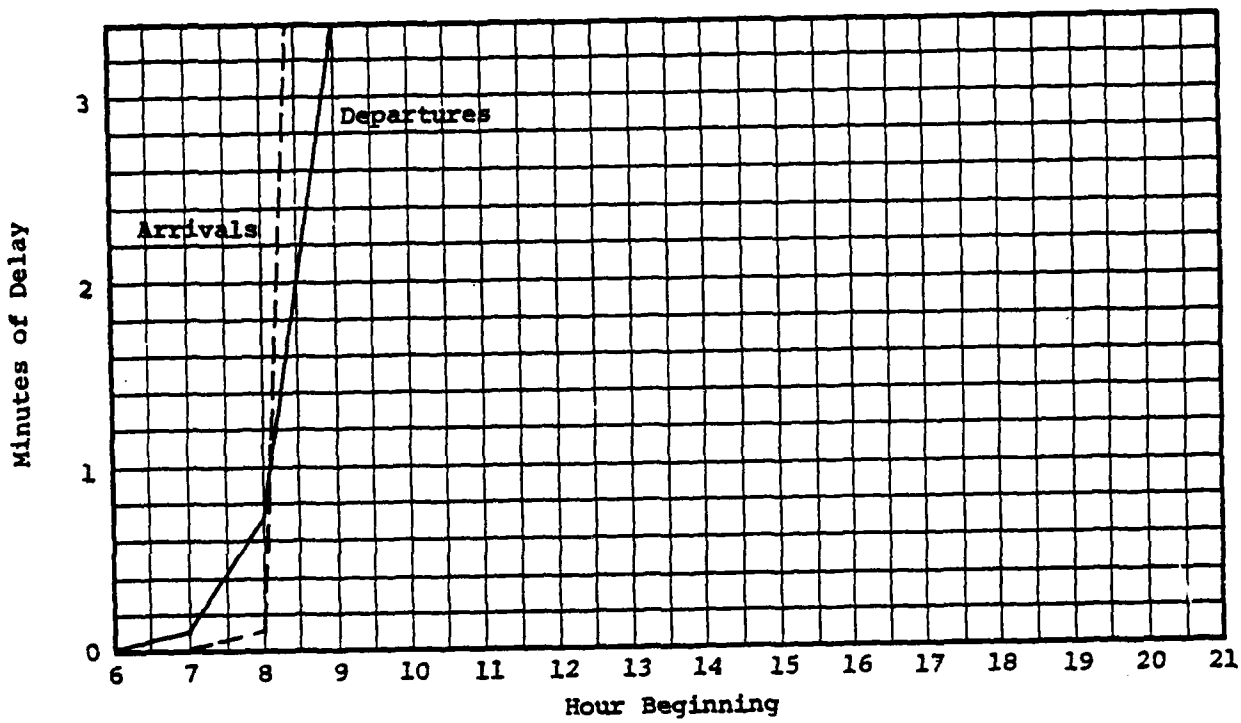
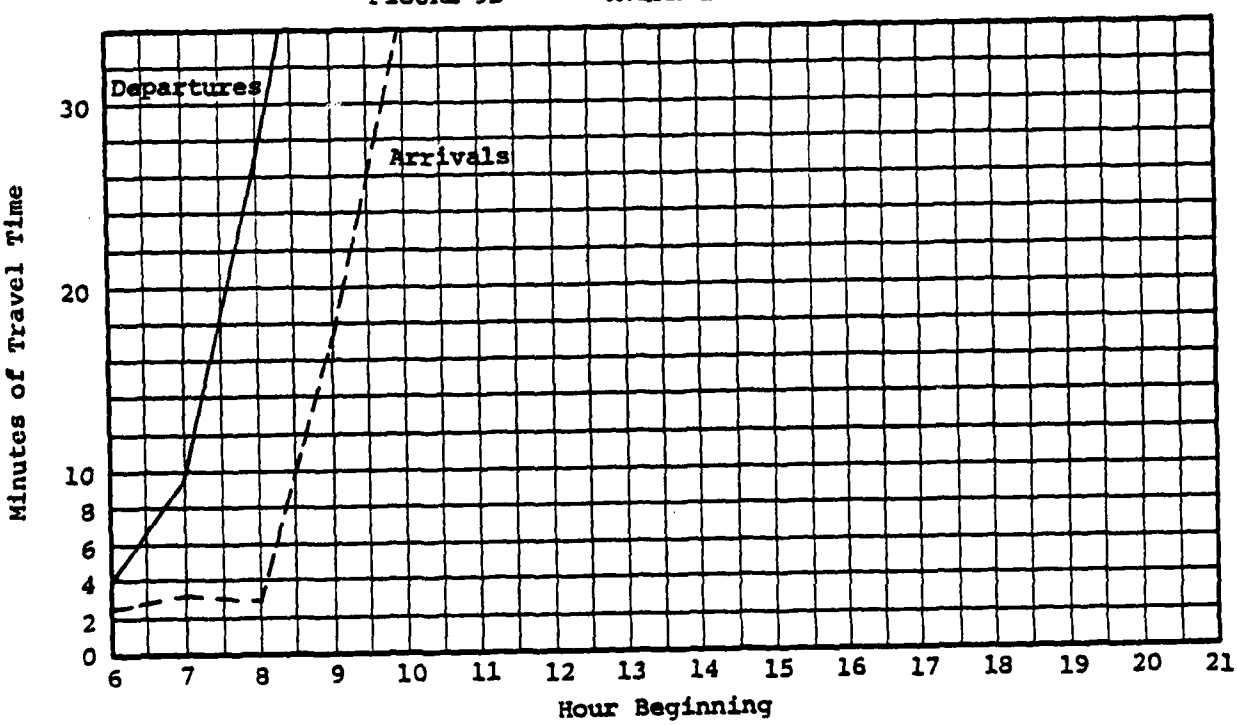


FIGURE 9D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 10

Objective:

To estimate the impact of the extensions of Taxiways L and V.

Related Comparison Experiments:

Experiment 9 is the 1977 baseline for comparison.

Results:

Figure 10A shows that total aircraft flows vary from 9 to 38 aircraft per hour over the 7 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 20 arrival aircraft and 18 departure aircraft.

Figure 10B shows that average delays to aircraft using the runways are as high as 136.2 minutes per aircraft. Peak hour average delays are 36.8 minutes for arrival aircraft and 136.2 minutes for departure aircraft.

Figure 10C shows that the peak-period average delays to aircraft using the taxiways are 51.0 minutes for taxi-in operations and 17.2 minutes for taxi-out operations.

Figure 10D shows that average aircraft taxi travel times vary from 2.4 to 144.3 minutes. Peak-hour average taxi travel times are 44.7 minutes for arrival aircraft and 144.3 minutes for departure aircraft.

FIGURE 10A AVERAGE RUNWAY FLOW RATES

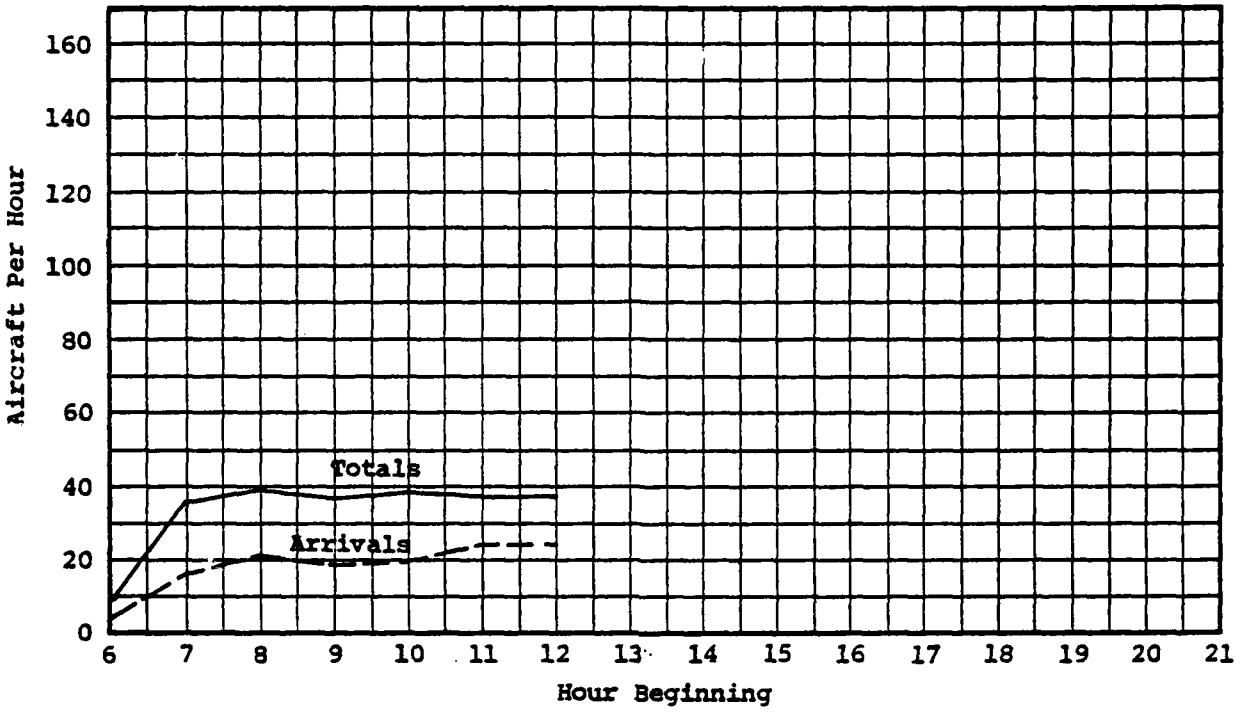


FIGURE 10B AVERAGE RUNWAY DELAYS

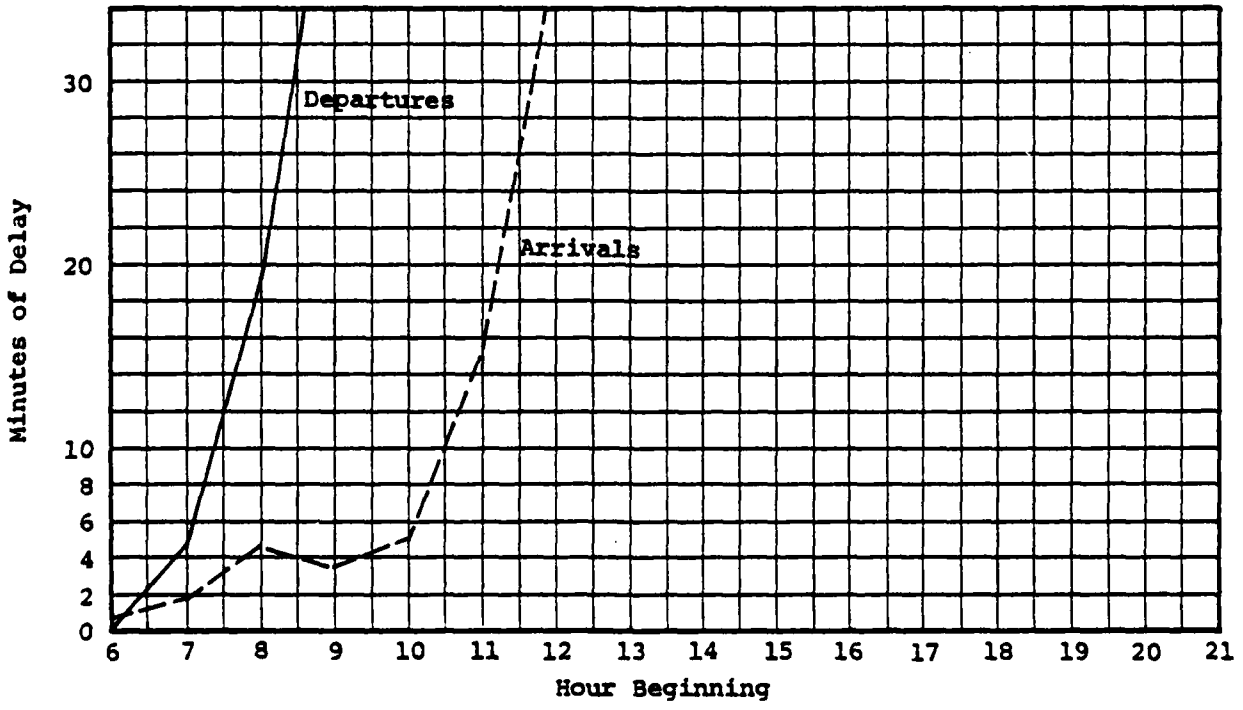


FIGURE 10C AVERAGE TAXIWAY DELAYS

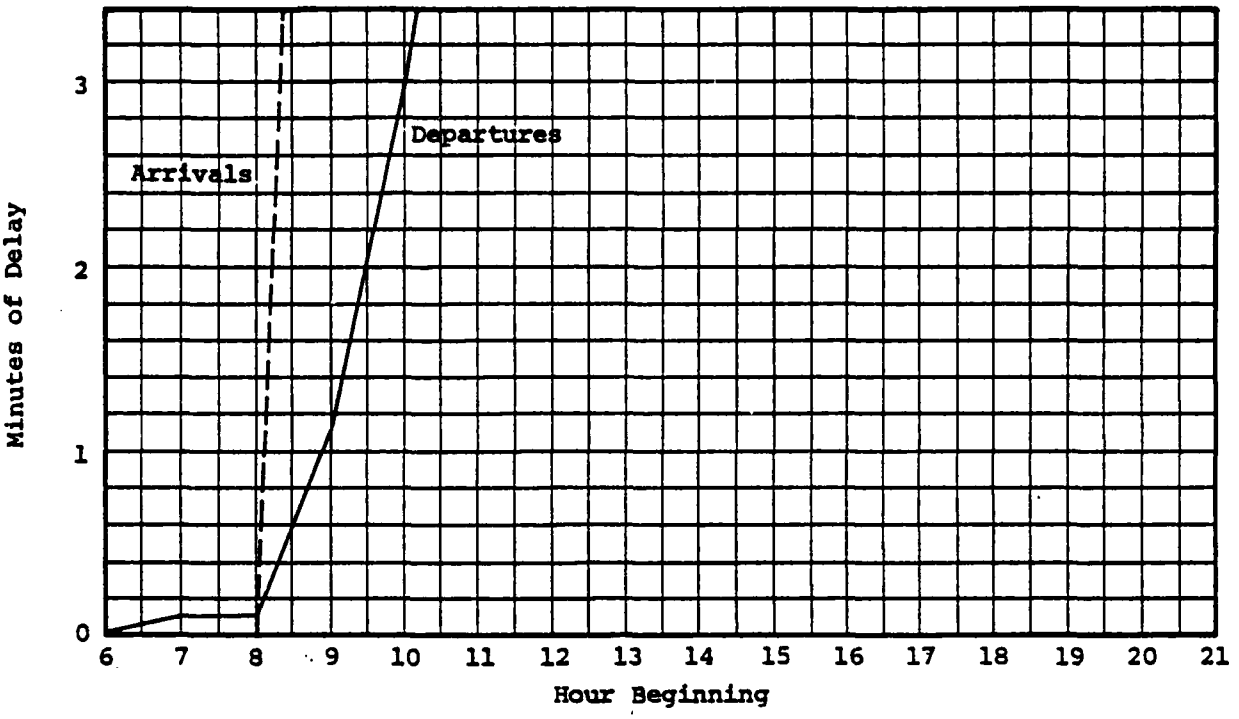
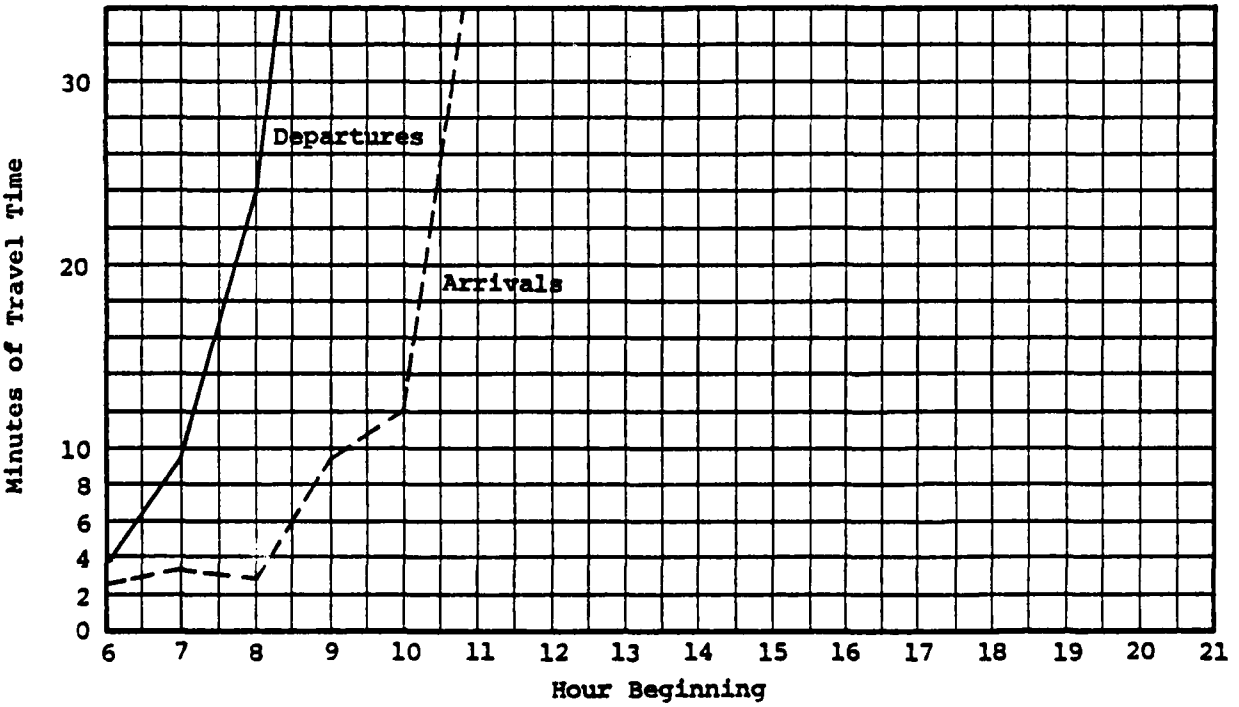


FIGURE 10D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 11

Objective:

To estimate the impacts of the extension of Runway 1L/19R with VASI on 19R.

Related Comparison Experiments:

Experiment 6 is the 1977 baseline for comparison.

Results:

Figure 11A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 11B shows that average delays to aircraft using the runways are as high as 6.3 minutes per aircraft. Peak hour average delays are 1.2 minutes for arrival aircraft and 6.3 minutes for departure aircraft.

Figure 11C shows that the peak-period average delays to aircraft using the taxiways are 0.4 minutes for taxi-in operations and 1.7 minutes for taxi-out operations.

Figure 11D shows that average aircraft taxi travel times vary from 2.4 to 11.6 minutes. Peak-hour average taxi travel times are 3.7 minutes for arrival aircraft and 11.6 minutes for departure aircraft.

FIGURE 11A AVERAGE RUNWAY FLOW RATES

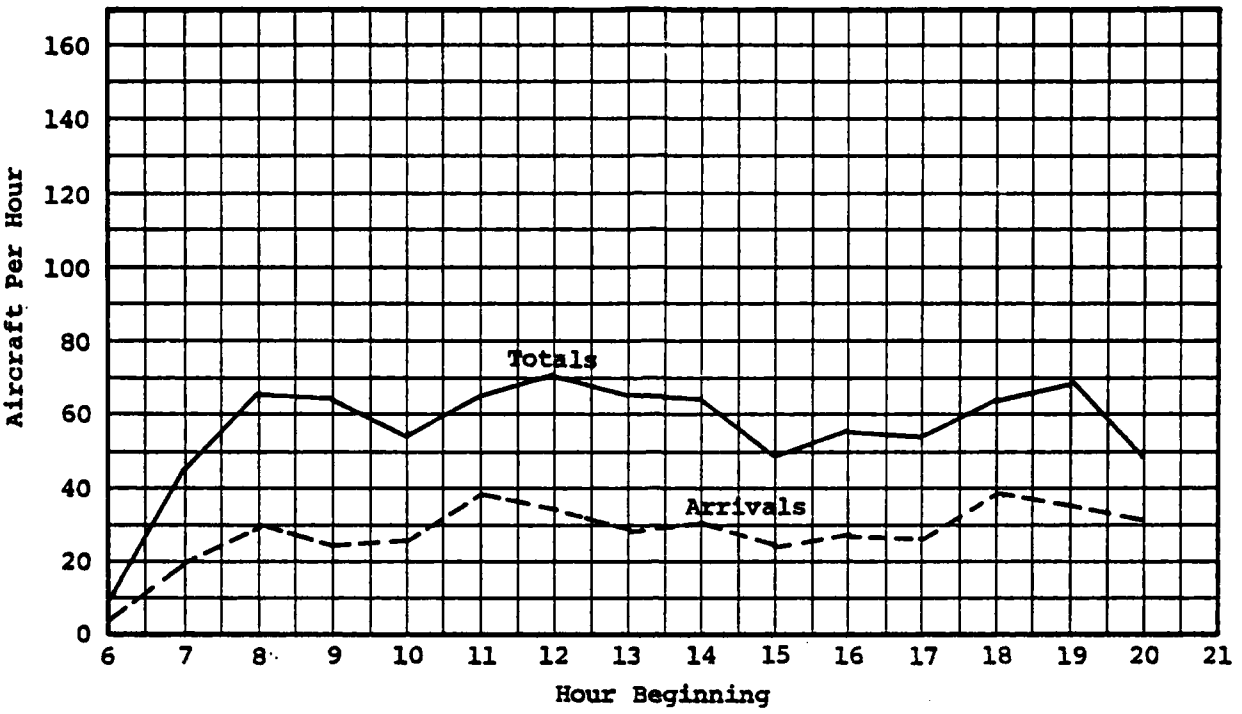


FIGURE 11B AVERAGE RUNWAY DELAYS

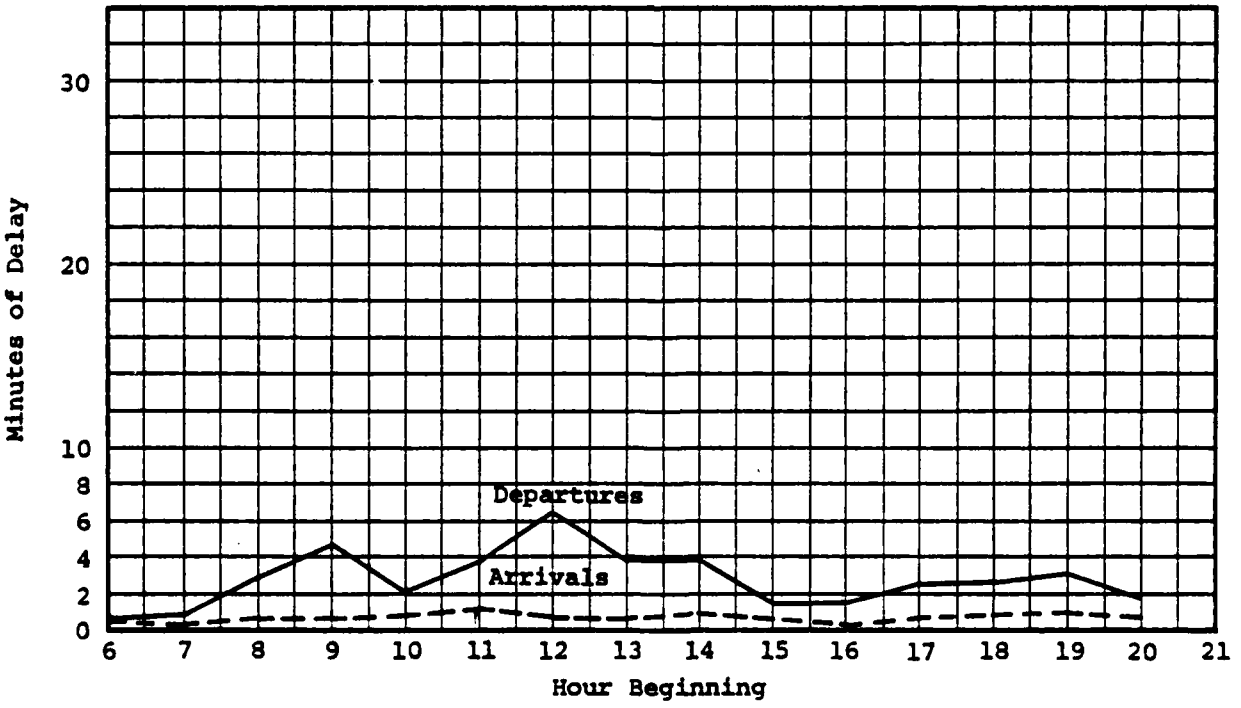


FIGURE 11C AVERAGE TAXIWAY DELAYS

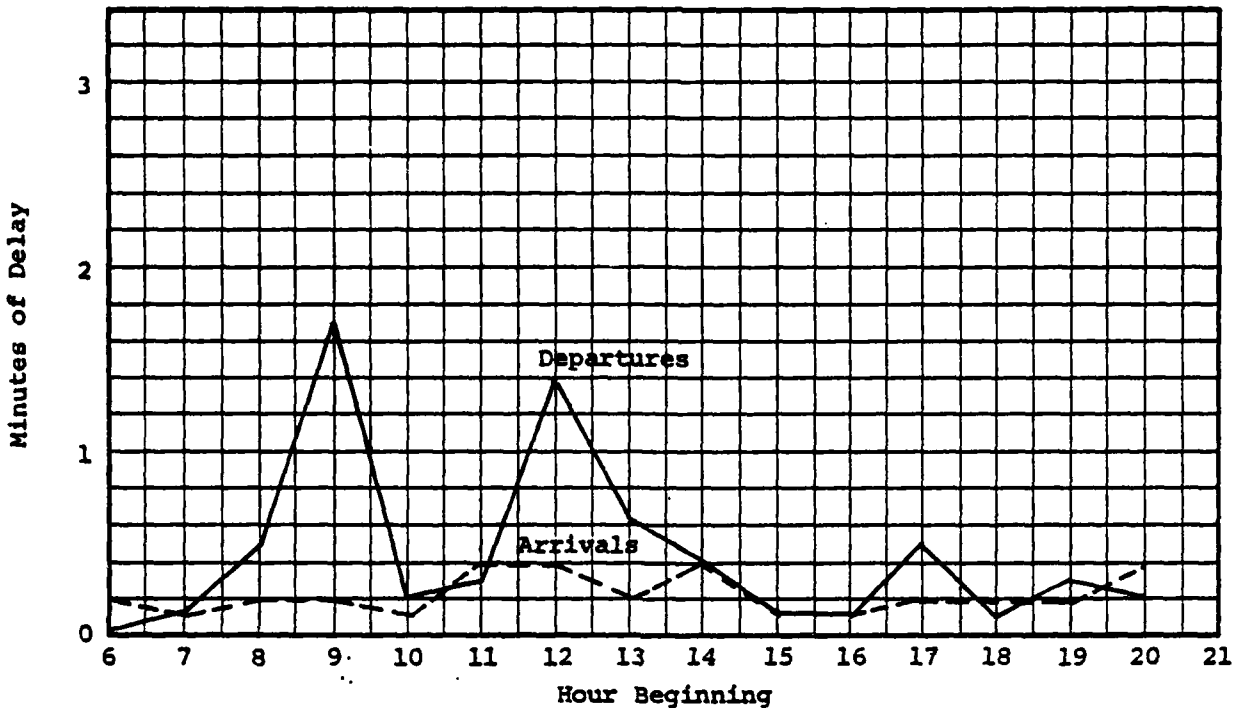
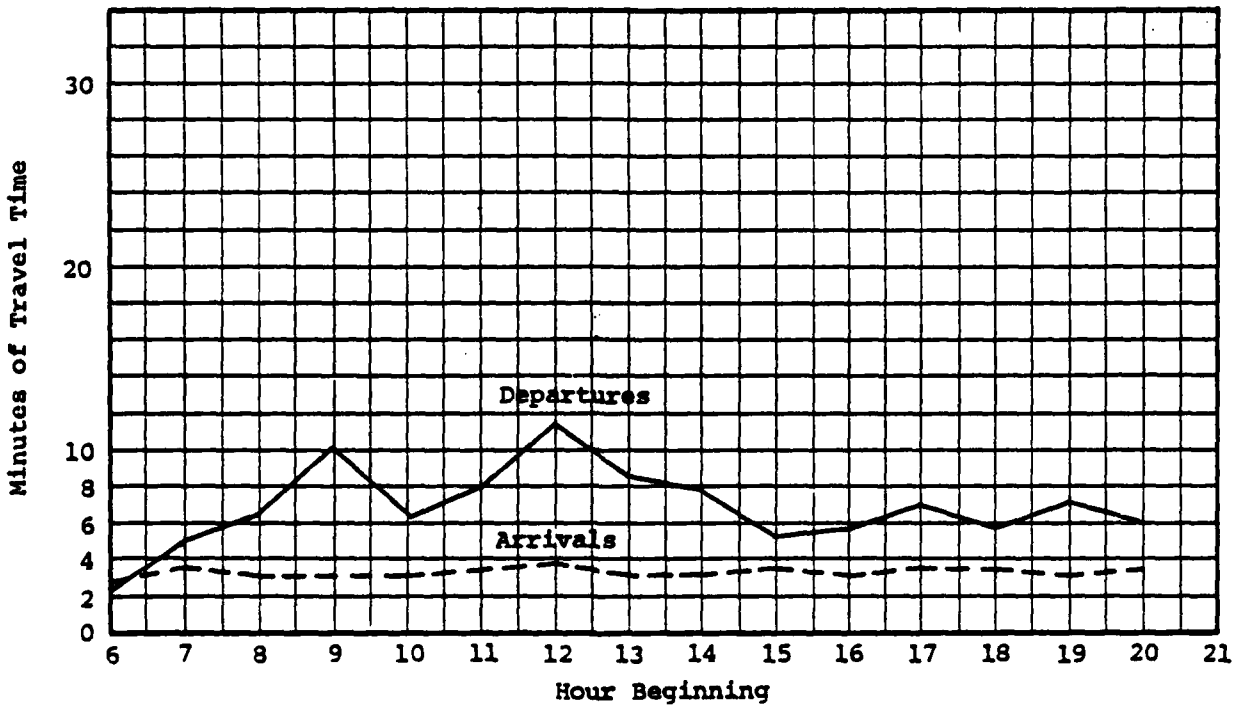


FIGURE 11D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 12

Objective:

To estimate the impact of the extension of Taxiway K with simultaneous departures on 10L and 10R permitted.

Related Comparison Experiments:

Experiment 6 is the 1977 baseline for comparison.

Results:

Figure 12A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 38 departure aircraft.

Figure 12B shows that average delays to aircraft using the runways are as high as 2.5 minutes per aircraft. Peak hour average delays are 1.1 minutes for arrival aircraft and 2.5 minutes for departure aircraft.

Figure 12C shows that the peak-period average delays to aircraft using the taxiways are 0.4 minutes for taxi-in operations and 0.2 minutes for taxi-out operations.

Figure 12D shows that average aircraft taxi travel times vary from 2.7 to 7.4 minutes. Peak-hour average taxi travel times are 3.6 minutes for arrival aircraft and 7.4 minutes for departure aircraft.

FIGURE 12A AVERAGE RUNWAY FLOW RATES

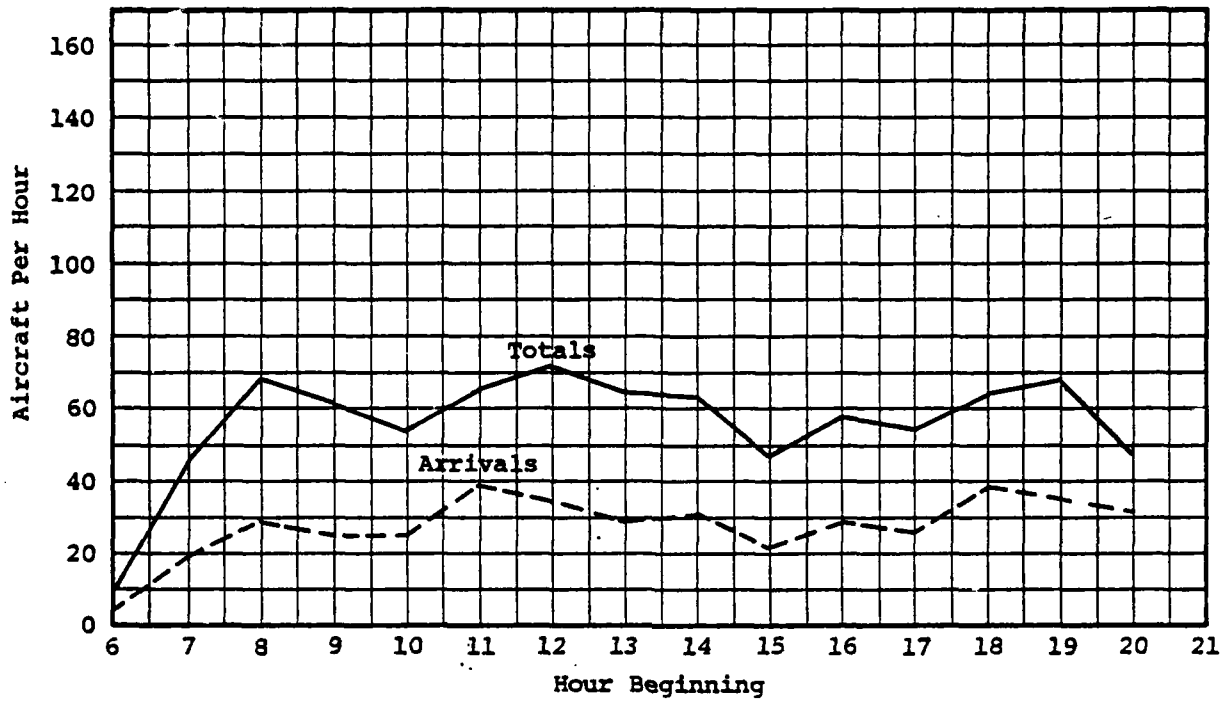


FIGURE 12B AVERAGE RUNWAY DELAYS

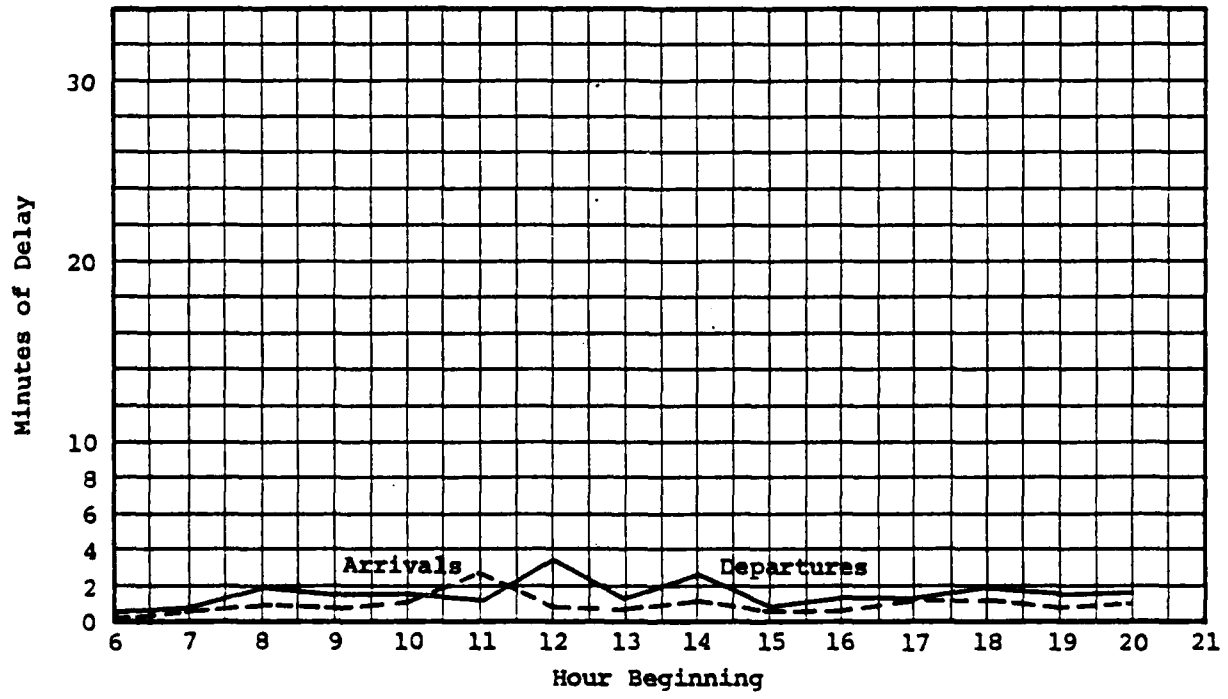


FIGURE 12C AVERAGE TAXIWAY DELAYS

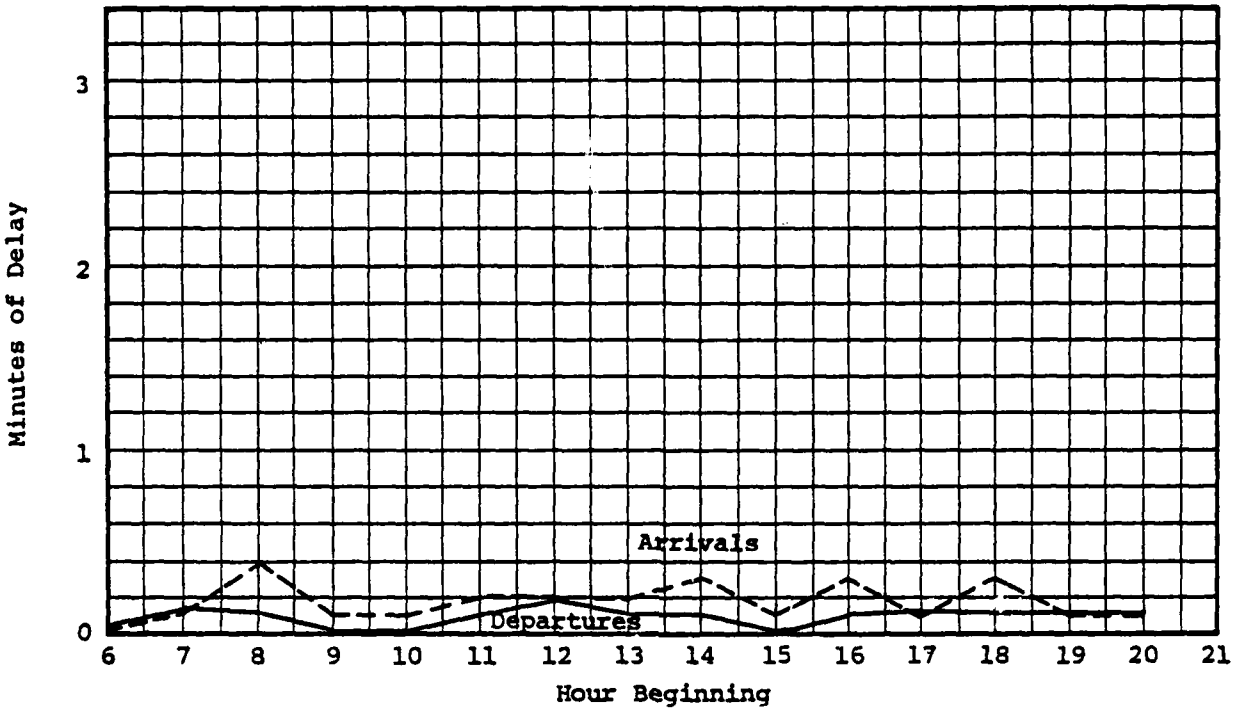
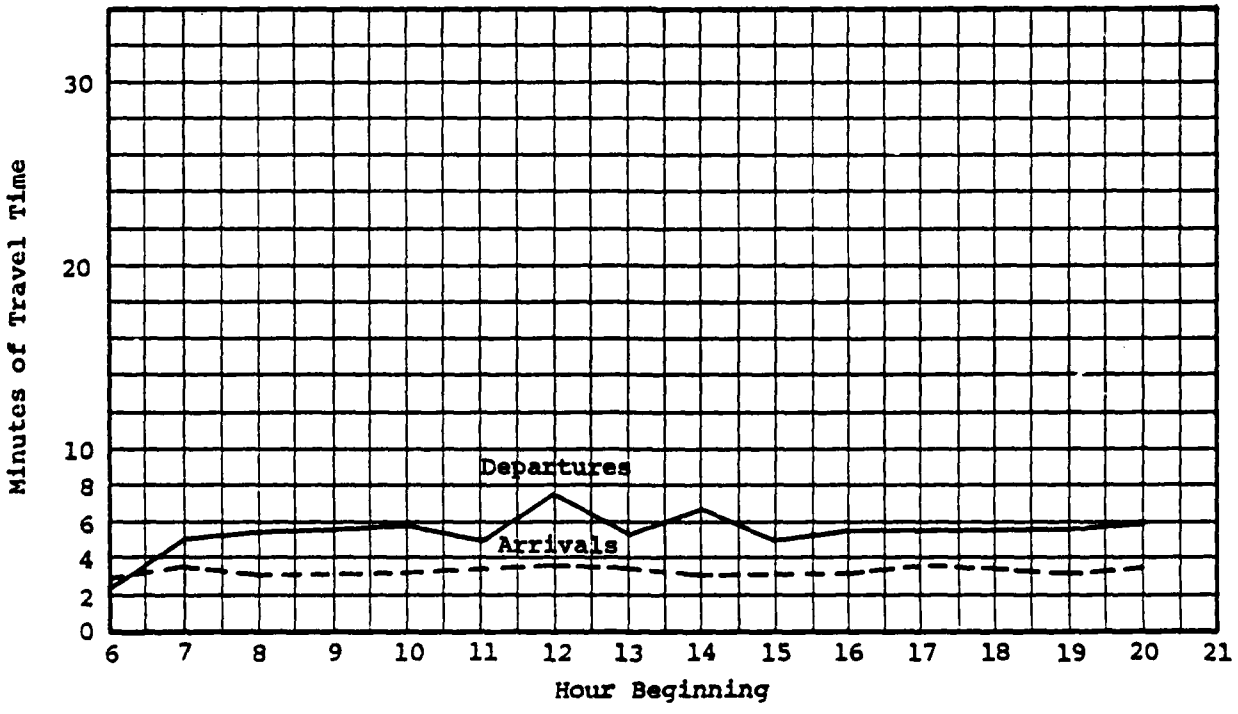


FIGURE 12D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 13

Objective:

To estimate the impact of using Taxiway L as a utility runway.

Related Comparison Experiments:

Experiment 14 is the 1977 baseline for comparison.

Results:

Figure 13A shows that total aircraft flows vary from 11 to 70 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 33 arrival aircraft and 37 departure aircraft.

Figure 13B shows that average delays to aircraft using the runways are as high as 3.6 minutes per aircraft. Peak hour average delays are 0.7 minutes for arrival aircraft and 36 minutes for departure aircraft.

Figure 13C shows that the peak-period average delays to aircraft using the taxiways are 0.4 minutes for taxi-in operations and 0.1 minutes for taxi-out operations.

Figure 13D shows that average aircraft taxi travel times vary from 2.6 to 7.6 minutes. Peak-hour average taxi travel times are 3.5 minutes for arrival aircraft and 7.6 minutes for departure aircraft.

FIGURE 13A AVERAGE RUNWAY FLOW RATES

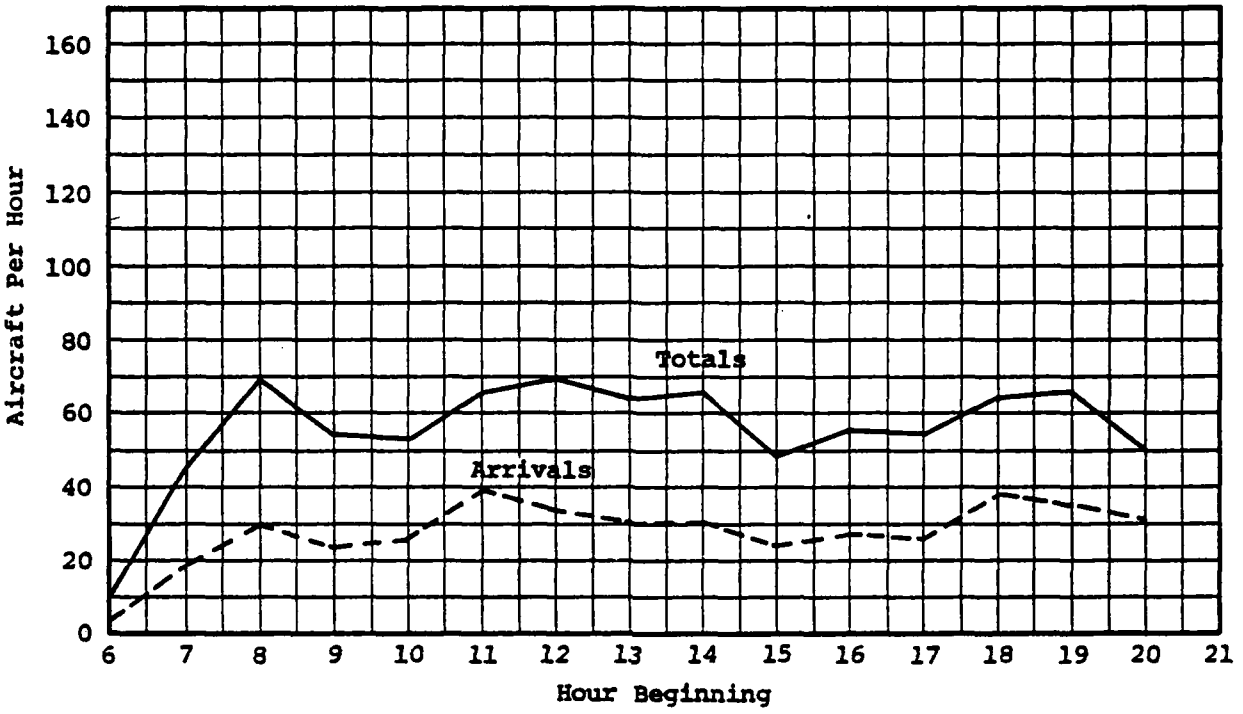


FIGURE 13B AVERAGE RUNWAY DELAYS

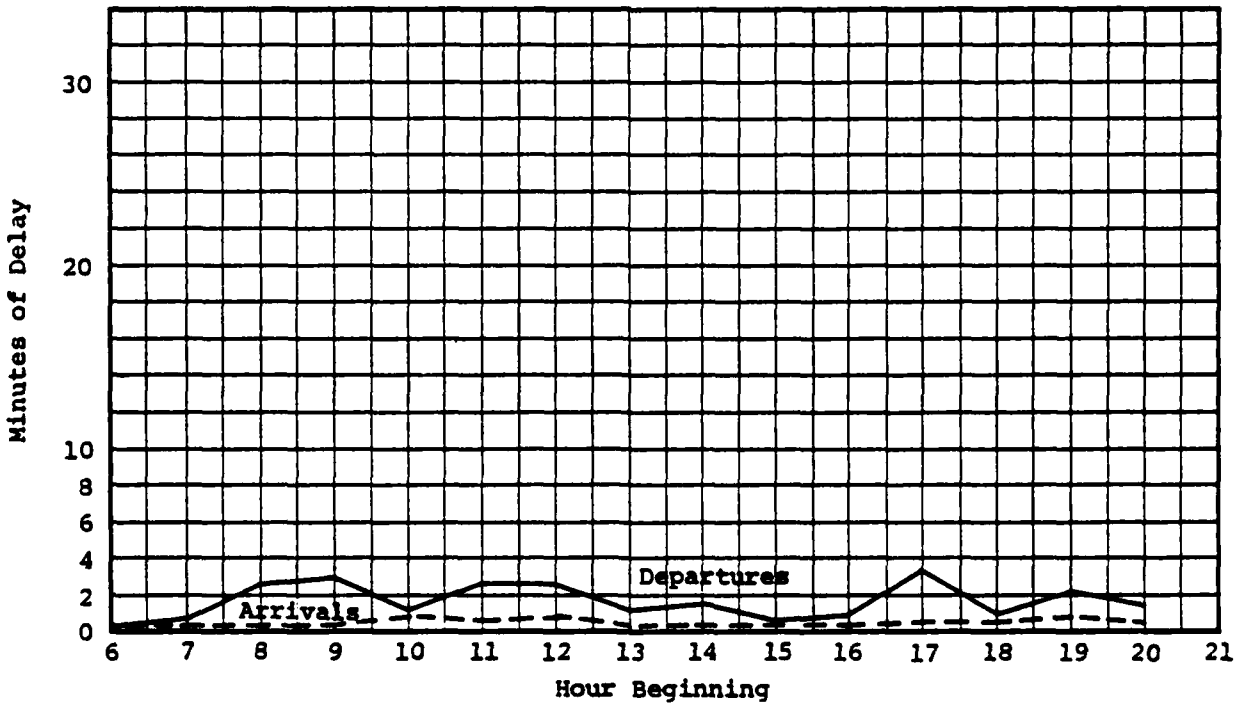


FIGURE 13C AVERAGE TAXIWAY DELAYS

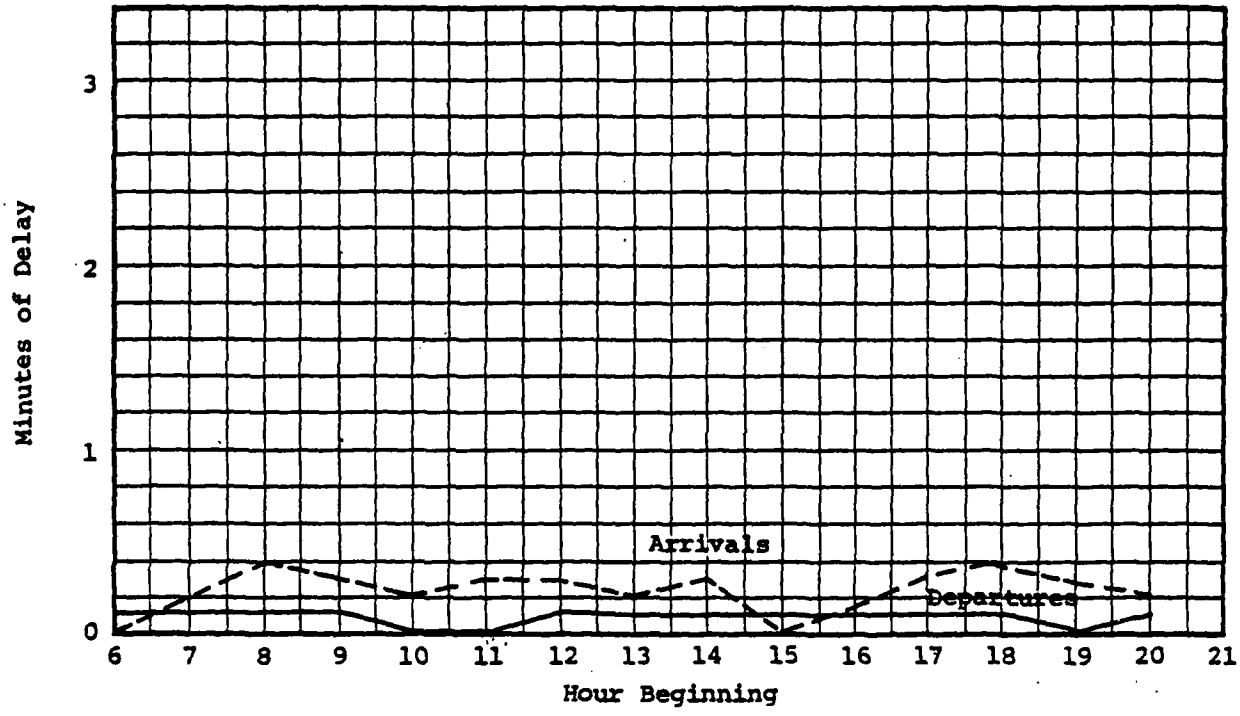
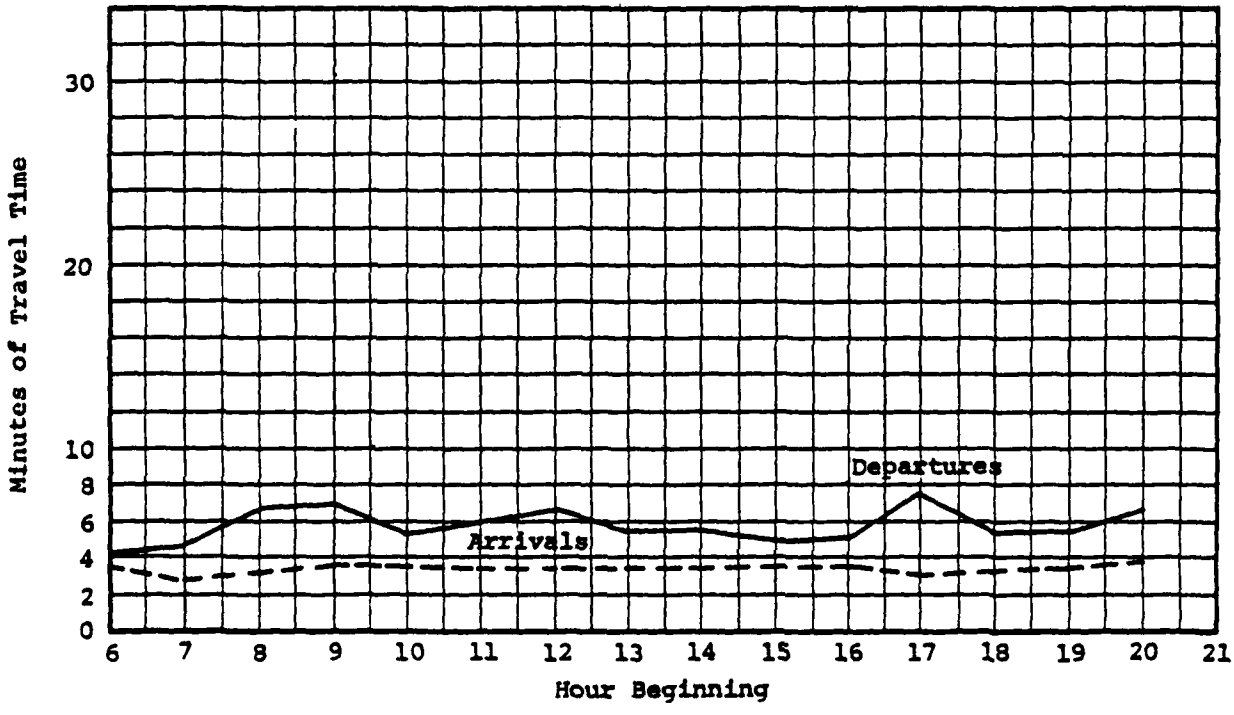


FIGURE 13D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 14

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR1 weather:

Arrival Runways	Departure Runways
28L, 28R	1L, 28L

Related Comparison Experiments:

Experiment 13 estimates the impact of using Taxiway L as a utility runway.

Results:

Figure 14A shows that total aircraft flows vary from 11 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 34 arrival aircraft and 37 departure aircraft.

Figure 14B shows that average delays to aircraft using the runways are as high as 10.9 minutes per aircraft. Peak hour average delays are 1.3 minutes for arrival aircraft and 10.9 minutes for departure aircraft.

Figure 14C shows that the peak-period average delays to aircraft using the taxiways are 0.8 minutes for taxi-in operations and 0.2 minutes for taxi-out operations.

Figure 14D shows that average aircraft taxi travel times vary from 2.5 to 14.4 minutes. Peak-hour average taxi travel times are 3.7 minutes for arrival aircraft and 14.4 minutes for departure aircraft.

FIGURE 14A AVERAGE RUNWAY FLOW RATES

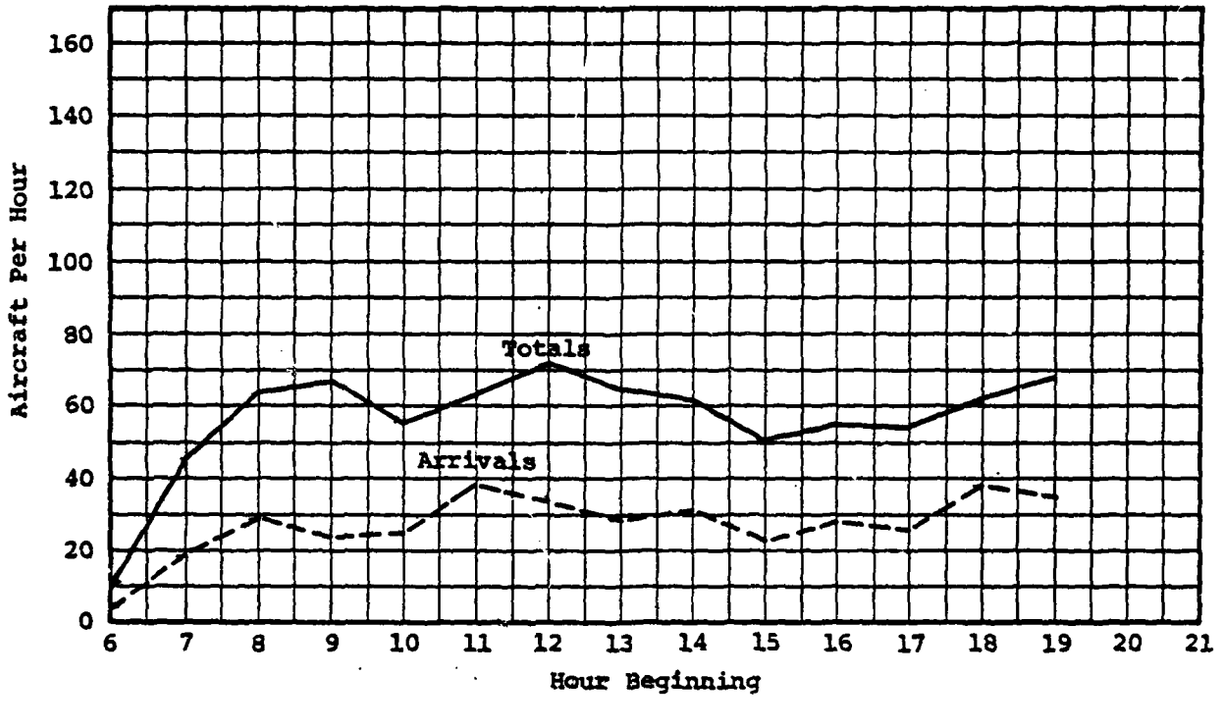


FIGURE 14B AVERAGE RUNWAY DELAYS

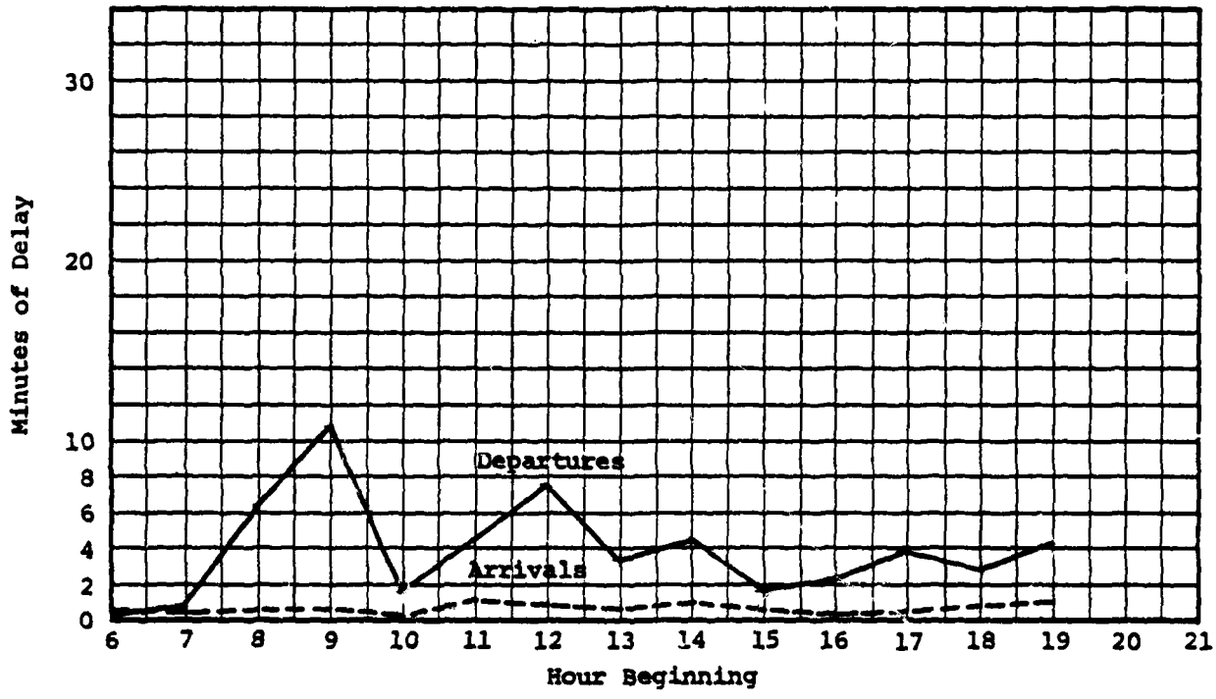


FIGURE 14C AVERAGE TAXIWAY DELAYS

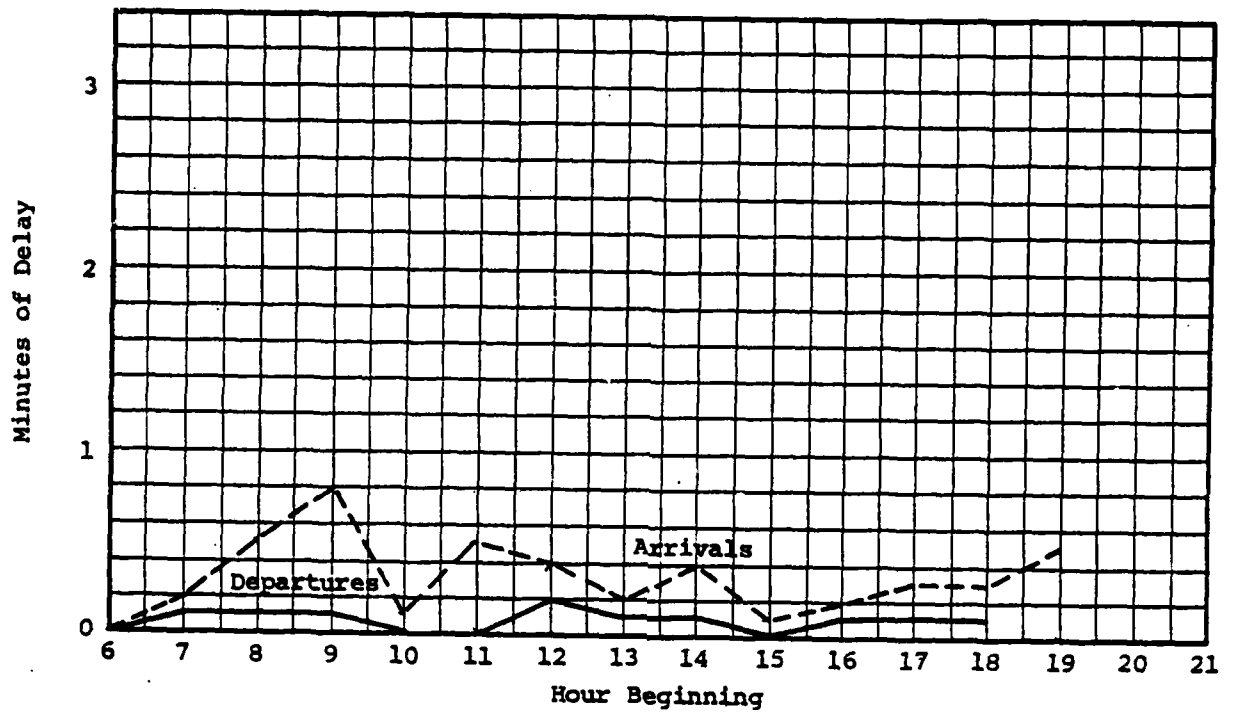
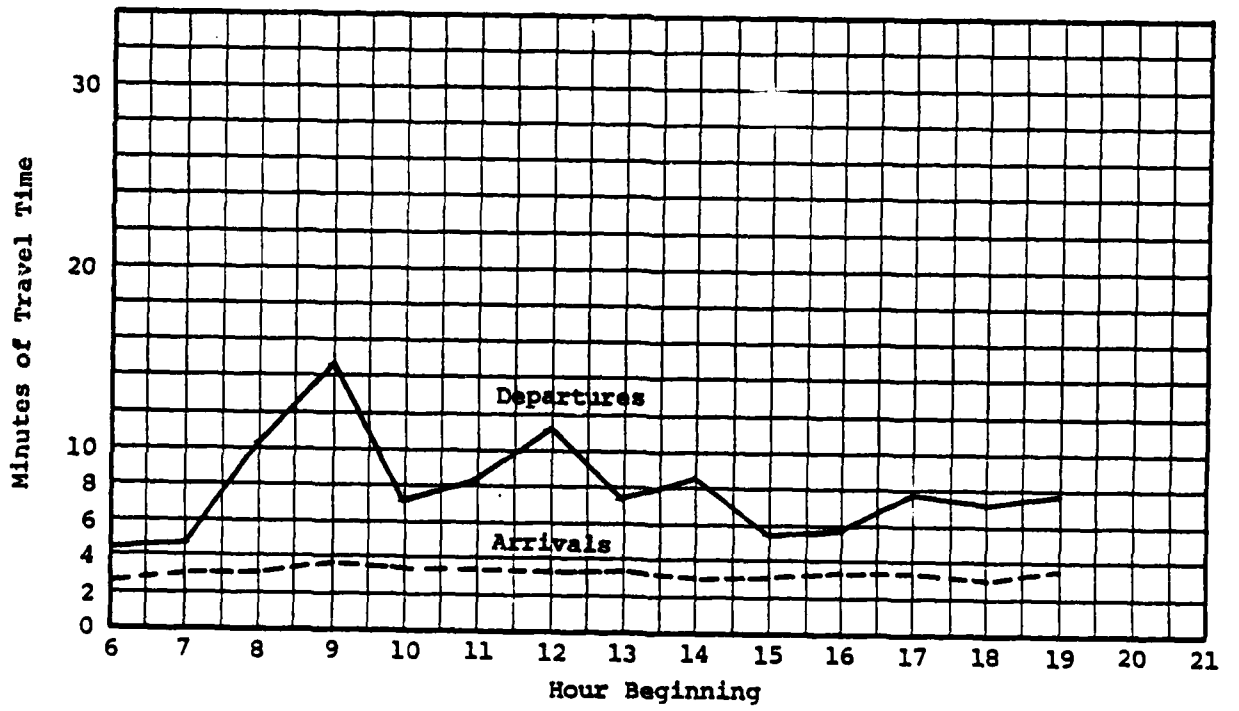


FIGURE 14D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 15

Objective:

To obtain 1977 baseline delay estimates for the following runway use in VFR1 weather:

Arrival Runways	Departure Runways
28L	28L, 28R

Related Comparison Experiments:

Experiment 18 estimates the impact of using Taxiway C as a utility runway.

Results:

Figure 15A shows that total aircraft flows vary from 9 to 69 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 31 arrival aircraft and 38 departure aircraft.

Figure 15B shows that average delays to aircraft using the runways are as high as 16.9 minutes per aircraft. Peak hour average delays are 16.9 minutes for arrival aircraft and 5.8 minutes for departure aircraft.

Figure 15C shows that the peak-period average delays to aircraft using the taxiways are 0 minutes for taxi-in operations and 3.1 minutes for taxi-out operations.

Figure 15D shows that average aircraft taxi travel times vary from 2.3 to 12.9 minutes. Peak-hour average taxi travel times are 3.9 minutes for arrival aircraft and 12.9 minutes for departure aircraft.

FIGURE 15A AVERAGE RUNWAY FLOW RATES

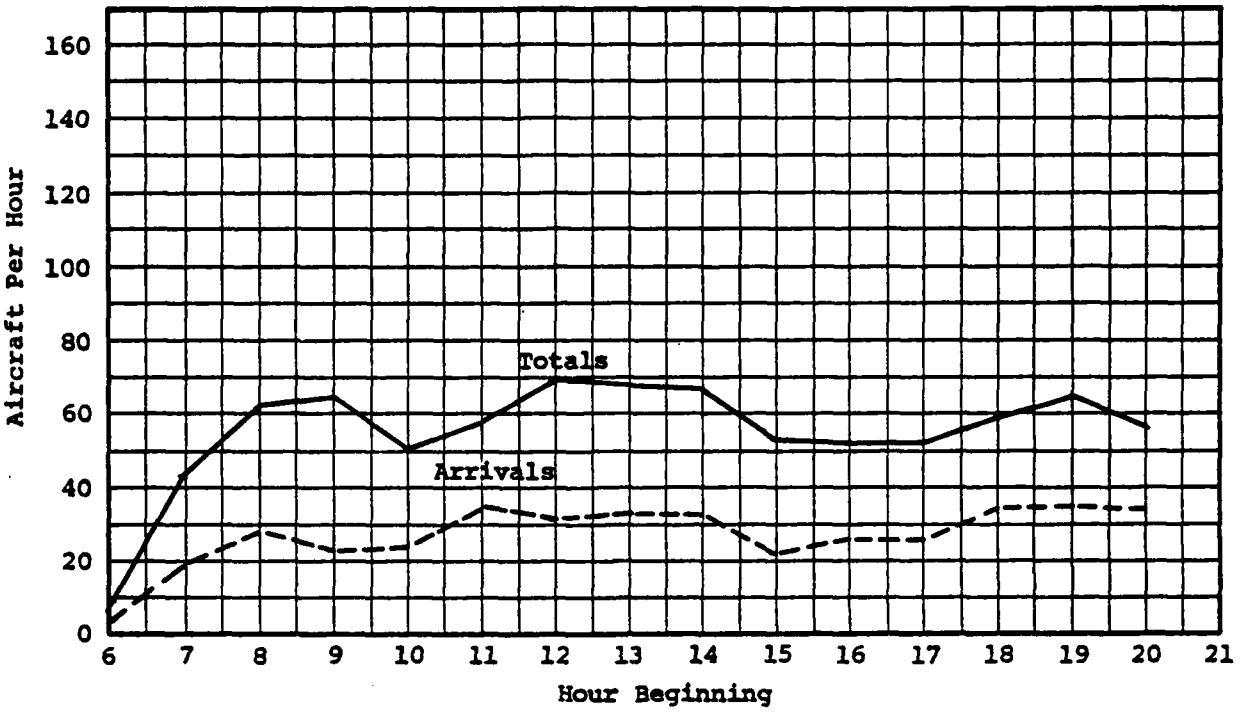


FIGURE 15B AVERAGE RUNWAY DELAYS

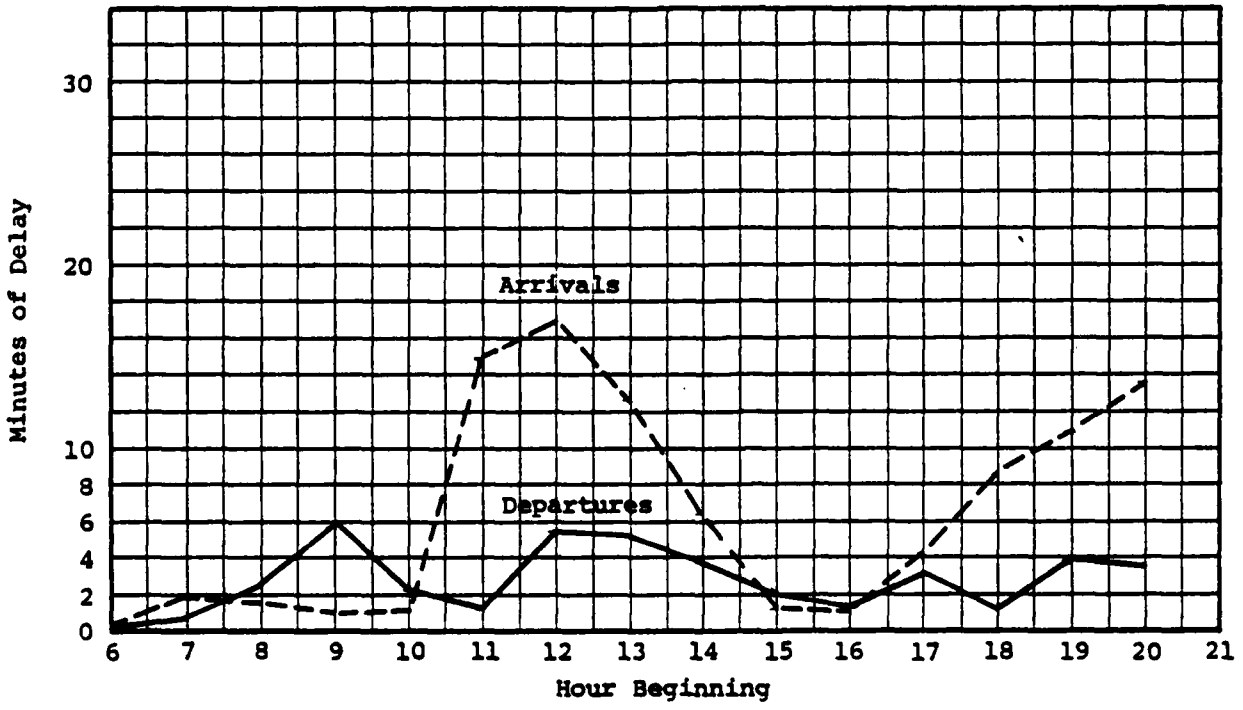


FIGURE 15C AVERAGE TAXIWAY DELAYS

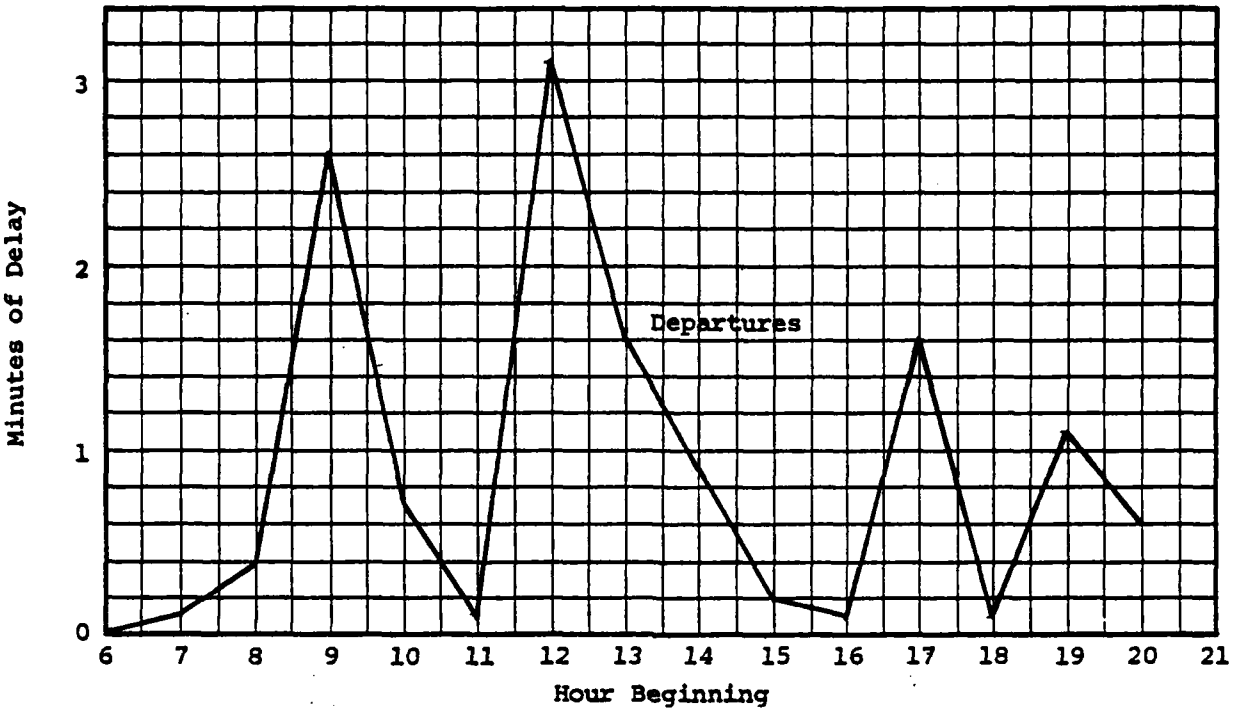
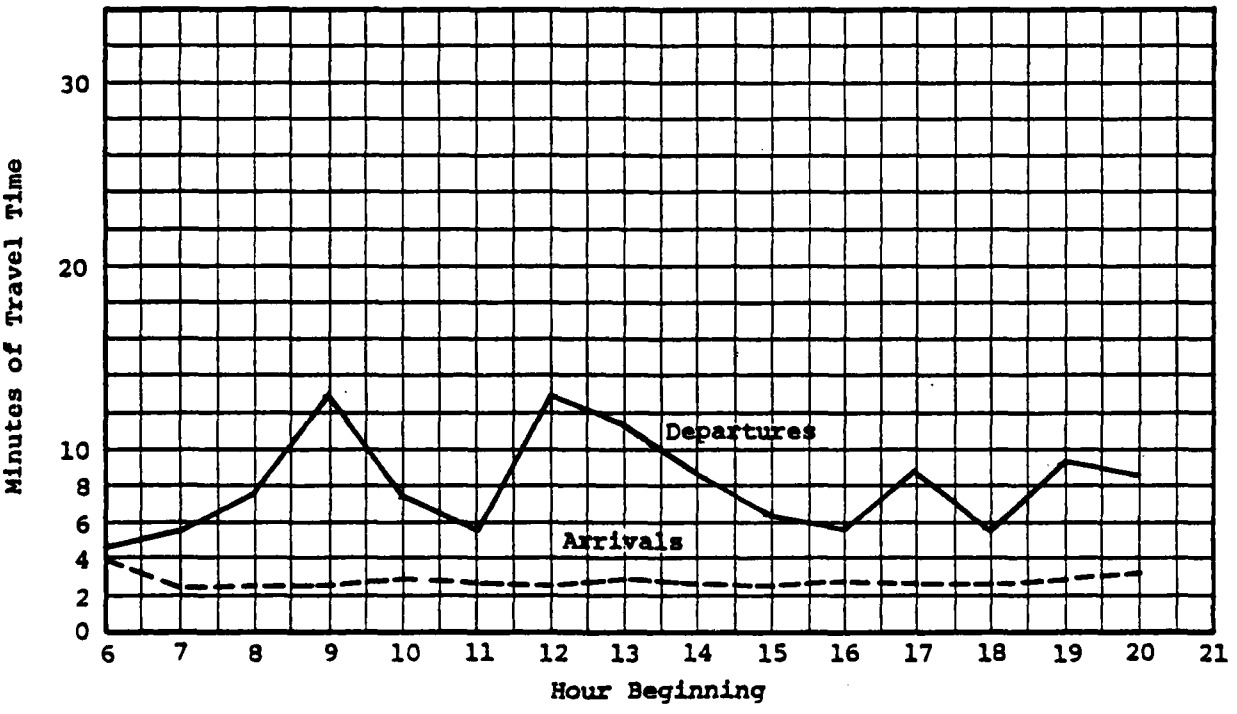


FIGURE 15D AVERAGE TAXIWAY TRAVEL TIMES



Experiment No. 16

Objective:

To obtain 1977 baseline delay estimates.

Related Comparison Experiments:

Experiment No. 17 estimates the impacts that Noise Abatement Operating Procedures have an airfield operations.

Results:

With an annual demand of 349,011 operations, average annual delays were estimated to be 2.0 minutes per aircraft. Eighty-one percent of the delays were less than or equal to one minute.

On the average day of the peak month, peak hour average delays are as high as 77 minutes (during IFR1 weather conditions with arrivals on Runways 28L/28R and departures on 1L/1R). For the most frequent combination of runway use and weather condition (VFR1 weather with arrivals on 28L/28R and departures on 1L/1R), average peak hour delays were 0.9 minutes.

Figure 16A--1977 ANNUAL DELAY BASELINE
ANNUAL SUMMARY

```
**********************************
*   AIRPORT STUDY CONDITIONS     *
*      SFIA 1977 NOISE RUN       *
**********************************
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ANNUAL SUMMARY

DEMAND TO CAPACITY (D/C RATIO) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.1	13.27
.1	TO	.2	10.72
.2	TO	.3	7.17
.3	TO	.4	8.31
.4	TO	.5	13.47
.5	TO	.6	21.41
.6	TO	.7	14.85
.7	TO	.8	5.19
.8	TO	.9	2.33
.9	TO	1.0	1.29
1.0	TO	1.1	.65
1.1	TO	1.2	.87
1.2	TO	1.3	.47

MEAN OF D/C RATIO = .44
STANDARD DEVIATION = .24

ANNUAL DELAY =11819.240 HOURS
ANNUAL DEMAND = 349011 OPERATIONS
AVERAGE DELAY = 2.03 MINUTES/AIRCRAFT

Figure 16B--1977 ANNUAL DELAY BASELINE
ANNUAL DELAY DISTRIBUTION

AVERAGE DELAY (MINUTES) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.2	8.370
.2	TO	.4	14.397
.4	TO	.6	24.818
.6	TO	.8	22.674
.8	TO	1.0	11.207
1.0	TO	1.2	4.913
1.2	TO	1.4	2.397
1.4	TO	1.6	1.305
1.6	TO	1.8	1.255
1.8	TO	2.0	.320
2.0	TO	3.0	2.211
3.0	TO	4.0	1.310
4.0	TO	5.0	.394
5.0	TO	6.0	.435
6.0	TO	7.0	.221
7.0	TO	8.0	.236
8.0	TO	9.0	.067
9.0	TO	10.0	.022
10.0	TO	11.0	.033
11.0	TO	12.0	.070
12.0	TO	13.0	.047
16.0	TO	17.0	.013
27.0	TO	28.0	.006
30.0	TO	31.0	.009
31.0	TO	32.0	.078
32.0	TO	33.0	.019
34.0	TO	35.0	.004
35.0	TO	36.0	.008
36.0	TO	37.0	.004
37.0	TO	38.0	.009
38.0	TO	39.0	.027
39.0	TO	40.0	.211
40.0	TO	41.0	.084
42.0	TO	43.0	.013
43.0	TO	44.0	.024
44.0	TO	45.0	.038
45.0	TO	46.0	.021
47.0	TO	48.0	.007
48.0	TO	49.0	.031
49.0	TO	50.0	.056
50.0	TO	51.0	.010
51.0	TO	52.0	.040
52.0	TO	53.0	.098
53.0	TO	54.0	.023
54.0	TO	55.0	.012
55.0	TO	56.0	.030
56.0	TO	57.0	.007
57.0	TO	58.0	.022
59.0	TO	60.0	.050
60.0	TO	61.0	.020
61.0	TO	62.0	.004
62.0	TO	63.0	.035
64.0	TO	65.0	.169
65.0	TO	66.0	.015
66.0	TO	67.0	.042
67.0	TO	68.0	.007
68.0	TO	69.0	.036
69.0	TO	70.0	.113
71.0	TO	72.0	.021
73.0	TO	74.0	.006
75.0	TO	76.0	.170
76.0	TO	77.0	.196
77.0	TO	78.0	.230
78.0	TO	79.0	.024
79.0	TO	80.0	.141

MEAN OF AVERAGE DELAY = 2.03
STANDARD DEVIATION = 2.93

Figure 16C--1977 ANNUAL DELAY BASELINE AVERAGE DAY, PEAK MONTH, PEAK HOUR DELAYS

AVERAGE PEAK HOUR DELAY FOR PEAK MONTH, AVG. DAY

RUNWAY USE	WEATHER GROUP	PERCENT OCCURRENCE	PEAK HOUR AVERAGE DELAY (MINUTES)	NUMBER OF SATURATED HOURS	NUMBER OF OVERLOAD HOURS
1	1	46.3	.9	0	0
1	2	5.2	2.0	0	0
1	3	1.6	77.1	13	13
1	4	3.8	7.8	4	2
1	5	2.4	3.3	0	0
1	6	1.6	3.3	0	0
1	7	0.0	0.0	0	0
1	8	0.0	0.0	0	0
1	9	5.0	2.3	0	0
1	10	1.0	3.9	4	2
1	11	0.0	0.0	0	0
1	12	0.0	0.0	0	0
1	13	24.4	1.2	0	0
1	14	.3	2.0	0	0
1	15	.2	57.6	16	11
1	16	.2	4.9	4	2
1	17	1.0	1.8	0	0
1	18	4.0	2.4	0	0
1	19	.4	66.1	13	13
1	20	.1	6.5	4	2
1	21	0.0	0.0	0	0
1	22	.6	4.3	4	2
1	23	.2	62.3	16	11
1	24	.2	50.2	17	13
1	25	.2	2.9	0	0
1	26	.6	3.1	0	0
1	27	0.0	0.0	0	0
1	28	0.0	0.0	0	0

Experiment No. 17

Objective:

To estimate the impacts that Noise Abatement Operating Procedures have an airfield operations.

Related Comparison Experiments:

Experiment No. 16 is the 1977 baseline for comparison.

Results:

With an annual demand of 349,011 operations and utilizing optional runway configurations, average annual delays were estimated to be 1.6 minutes per aircraft. Eighty-three percent of the delays were less than or equal to one minute.

On the average day of the peak month, peak hour average delays are as high as 62 minutes (during IFR1 weather conditions with arrivals and departures on 19L/R). For the most frequent combination of runway use and weather condition (VFR1 weather conditions with arrivals on 28L/28R and departures on 1L/1R), average peak hour delays were 0.9 minutes.

Figure 17A--1977 NOISE ABATEMENT PROCEDURES ANNUAL SUMMARY

```
**********************************
*   AIRPORT STUDY CONDITIONS     *
*      SFIA 1977 NOISE RUN       *
**********************************
```

ANNUAL SUMMARY

DEMAND TO CAPACITY (D/C RATIO) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.1	13.49
.1	TO	.2	11.02
.2	TO	.3	6.91
.3	TO	.4	8.48
.4	TO	.5	13.83
.5	TO	.6	22.29
.6	TO	.7	15.10
.7	TO	.8	4.67
.8	TO	.9	1.67
.9	TO	1.0	.92
1.0	TO	1.1	.50
1.1	TO	1.2	.66
1.2	TO	1.3	.46

MEAN OF D/C RATIO = .43
STANDARD DEVIATION = .24

ANNUAL DELAY = 3055.597 HOURS
ANNUAL DEMAND = 349011 OPERATIONS
AVERAGE DELAY = 1.56 MINUTES/AIRCRAFT

Figure 17B--1977 NOISE ABATEMENT PROCEDURES
ANNUAL DELAY DISTRIBUTION

AVERAGE DELAY (MINUTES) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.2	8.482
.2	TO	.4	14.697
.4	TO	.6	25.510
.6	TO	.8	23.268
.8	TO	1.0	11.317
1.0	TO	1.2	4.823
1.2	TO	1.4	2.212
1.4	TO	1.6	1.770
1.6	TO	1.8	1.128
1.8	TO	2.0	.803
2.0	TO	3.0	2.171
3.0	TO	4.0	1.121
4.0	TO	5.0	.299
5.0	TO	6.0	.174
6.0	TO	7.0	.263
7.0	TO	8.0	.246
8.0	TO	9.0	.017
9.0	TO	10.0	.020
10.0	TO	11.0	.002
27.0	TO	28.0	.063
30.0	TO	31.0	.054
32.0	TO	33.0	.011
34.0	TO	35.0	.021
36.0	TO	37.0	.037
37.0	TO	38.0	.082
38.0	TO	39.0	.027
39.0	TO	40.0	.032
40.0	TO	41.0	.026
42.0	TO	43.0	.027
43.0	TO	44.0	.005
45.0	TO	46.0	.152
47.0	TO	48.0	.001
48.0	TO	49.0	.105
49.0	TO	50.0	.052
50.0	TO	51.0	.010
52.0	TO	53.0	.103
53.0	TO	54.0	.005
55.0	TO	56.0	.095
56.0	TO	57.0	.069
57.0	TO	58.0	.143
59.0	TO	60.0	.079
60.0	TO	61.0	.135
61.0	TO	62.0	.016
62.0	TO	63.0	.188
64.0	TO	65.0	.052
65.0	TO	66.0	.008
66.0	TO	67.0	.008
68.0	TO	69.0	.051
73.0	TO	74.0	.006
76.0	TO	77.0	.012

MEAN OF AVERAGE DELAY = 1.56
STANDARD DEVIATION = 2.95

Figure 17C--1977 NOISE ABATEMENT PROCEDURES AVERAGE DAY, PEAK MONTH, PEAK HOUR DELAYS

AVERAGE PEAK HOUR DELAY FOR PEAK MONTH, AVG. DAY

RUNWAY USE	WEATHER GROUP	PERCENT OCCURRENCE	PEAK HOUR AVERAGE DELAY (MINUTES)	NUMBER OF SATURATED HOURS	NUMBER OF OVERLOAD HOURS
1	1	46.3	.9	0	0
1	2	0.0	0.0	0	0
1	3	0.0	0.0	0	0
1	4	0.0	0.0	0	0
2	1	2.4	3.3	0	0
2	2	1.6	3.3	0	0
2	3	0.0	0.0	0	0
2	4	0.0	0.0	0	0
4	1	29.4	1.2	0	0
4	2	6.5	2.0	0	0
4	3	1.3	57.6	16	11
4	4	4.0	4.9	4	2
5	1	1.0	1.3	0	0
5	2	4.6	2.4	0	0
5	3	0.0	0.0	0	0
5	4	.5	6.5	4	2
6	1	0.0	0.0	0	0
6	2	0.0	0.0	0	0
6	3	.6	62.3	16	11
6	4	.2	50.2	17	13
9	1	.2	2.9	0	0
9	2	.6	3.1	0	0
9	3	0.0	0.0	0	0
9	4	0.0	0.0	0	0

Experiment No. 18

Objective:

To estimate the impact of using Taxiway C as a utility runway.

Related Comparison Experiments:

Experiment 15 is the 1977 baseline for comparison.

Results:

Figure 18A shows that total aircraft flows vary from 9 to 71 aircraft per hour over the 15 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 32 arrival aircraft and 39 departure aircraft.

Figure 18B shows that average delays to aircraft using the runways are as high as 5.0 minutes per aircraft. Peak hour average delays are 5.0 minutes for arrival aircraft and 3.9 minutes for departure aircraft.

Figure 18C shows that the peak-period average delays to aircraft using the taxiways are 0.9 minutes for taxi-in operations and 1.2 minutes for taxi-out operations.

Figure 18D shows that average aircraft taxi travel times vary from 2.8 to 9.6 minutes. Peak-hour average taxi travel times are 4.7 minutes for arrival aircraft and 9.6 minutes for departure aircraft.

FIGURE 18A AVERAGE RUNWAY FLOW RATES

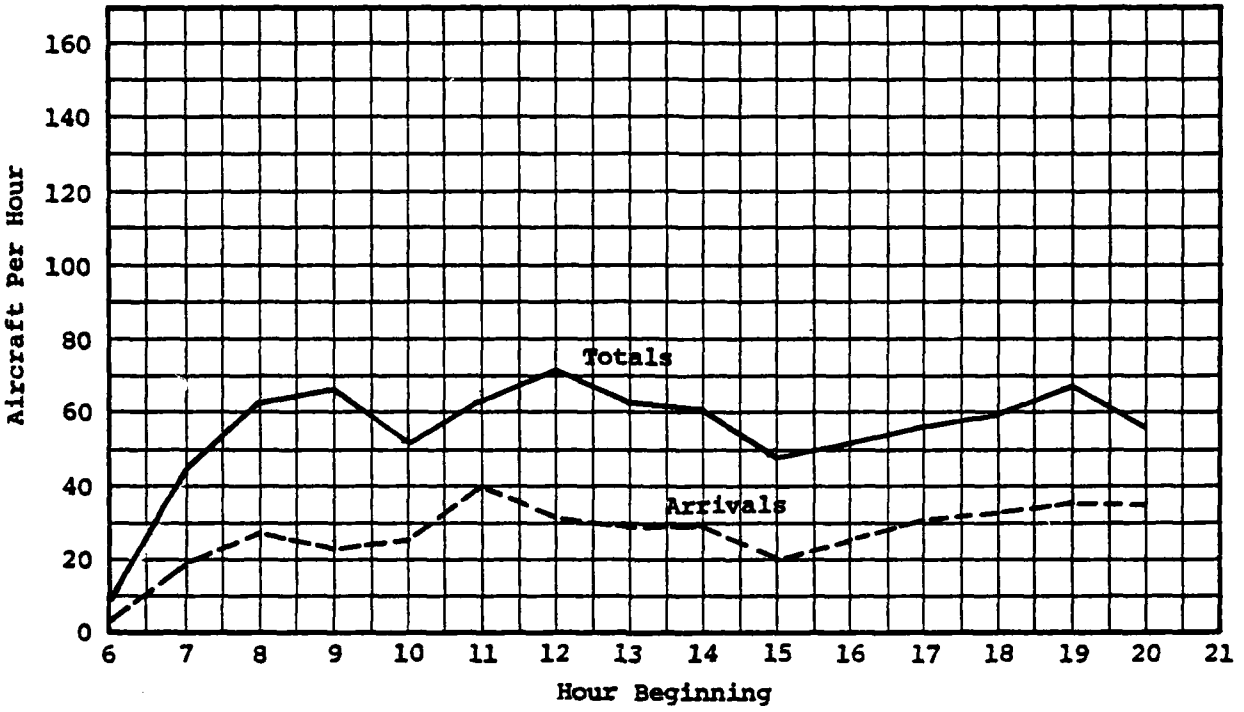


FIGURE 18B AVERAGE RUNWAY DELAYS

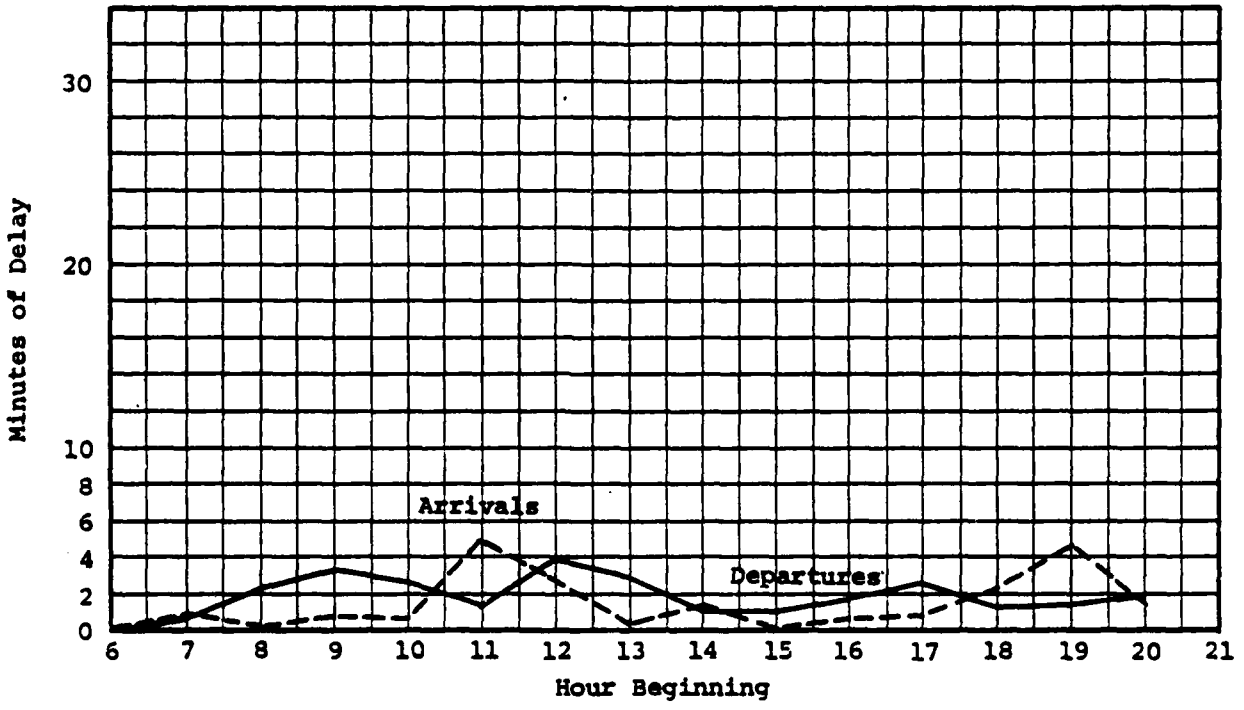


FIGURE 18C AVERAGE TAXIWAY DELAYS

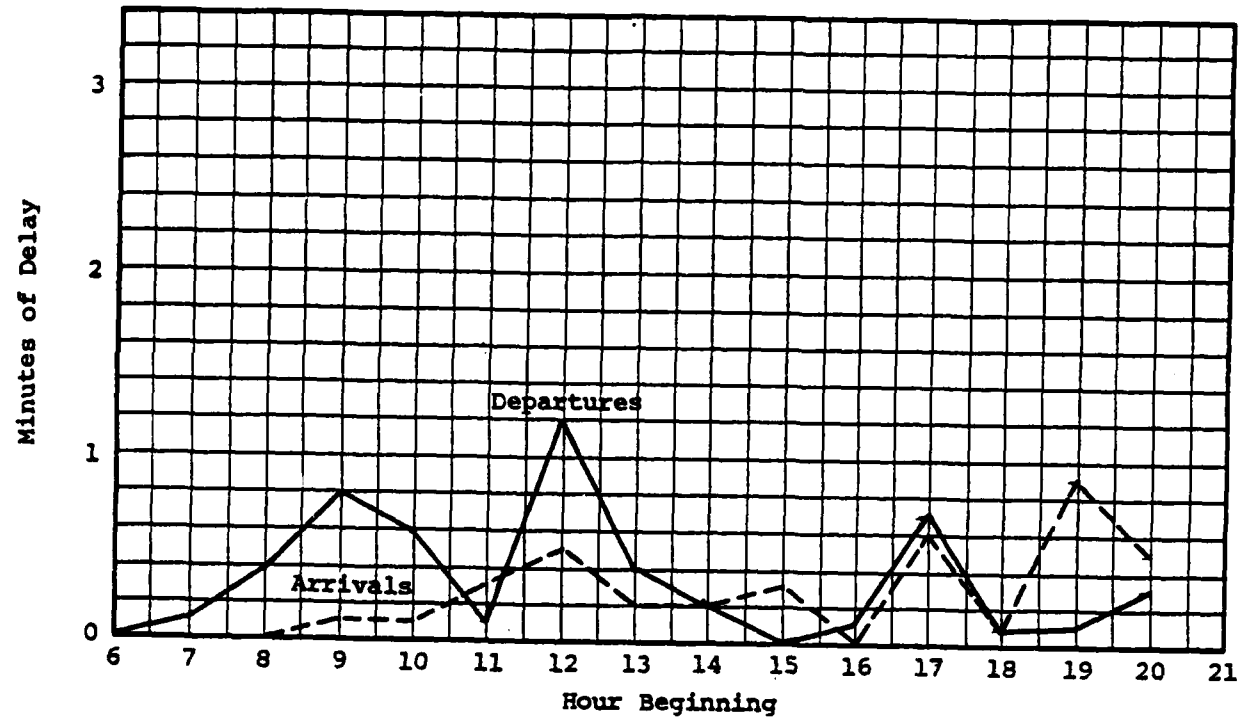
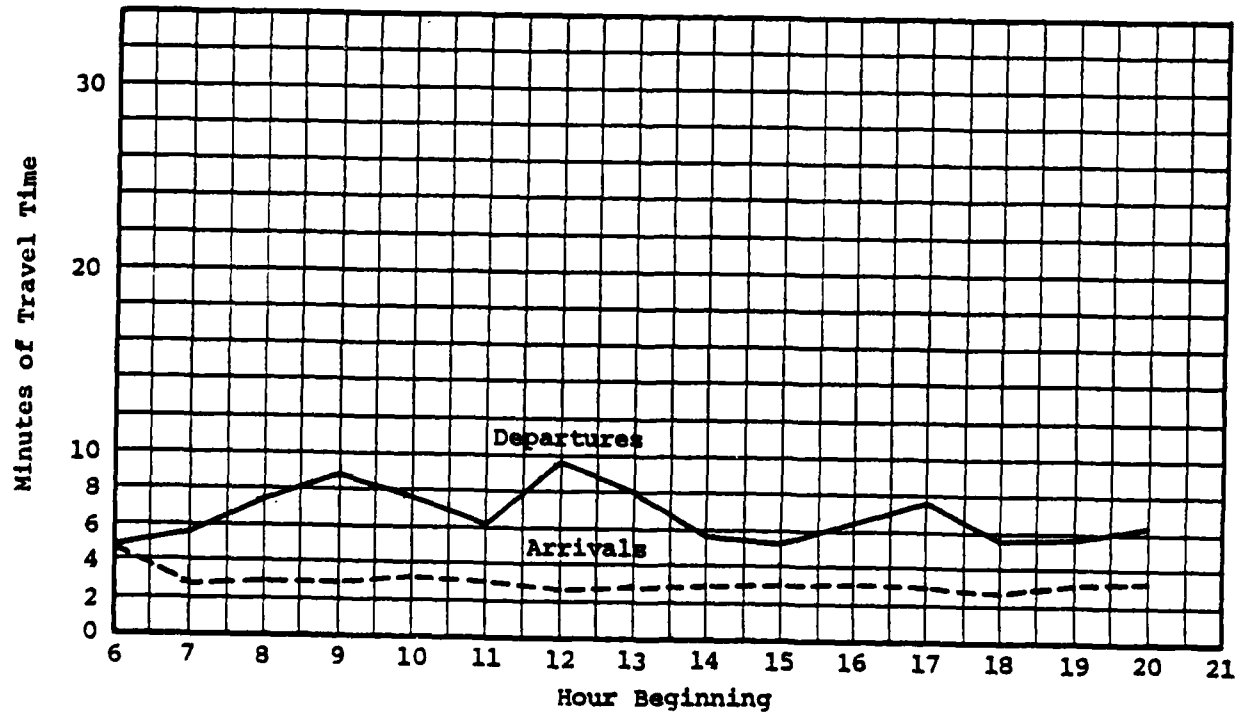


FIGURE 18D AVERAGE TAXIWAY TRAVEL TIMES



Attachment B

DATA FOR STAGE 2 EXPERIMENTS

San Francisco International Airport

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.
San Francisco, California

October 1978

STAGE 2 EXPERIMENTS
San Francisco International Airport
Airport Improvement Task Force Delay Studies

Experiment Number	Page Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
19	62	ASM	28L, 28R, 1L	1L, 1R, 28R	VFR 1	1982	1982	All[a]
20	73	ASM	28R	1L, 1R, 28L	IFR 1	1982	1982	All
21	74	ASM	28R	28L	IFR 1	1982	1982	All
22	75	ASM	19L, 19R	10L, 10R, 19R	VFR 1	1982	1982	All
23	82	ASM	19L	19L, 19R	IFR 2	1982	1982	All
24	83	ADM	n.a.	n.a.	n.a.	1982	Today	None
25	86	ADM	n.a.	n.a.	n.a.	1982	Today	All
26	86	ADM	n.a.	n.a.	n.a.	1982	1982	All
27	86	ADM	n.a.[b]	n.a.[b]	n.a.	1982	1982	None
28	86	ADM	n.a.[b]	n.a.[b]	n.a.	1982	1982	All
29	86	ADM	n.a.	n.a.	n.a.	1987	Today	None
30	86	ADM	n.a.	n.a.	n.a.	1987	Today	All
31	86	ADM	n.a.	n.a.	n.a.	1987	1987	All
32	86	ADM	n.a.[b]	n.a.[b]	n.a.	1987	1987	None
33	86	ADM	n.a.[b]	n.a.[b]	n.a.	1987	1987	All

a. All near-term improvements as follows: Extend taxiways, L, V, K; extend 1L/19R, VASI on 19R; 10L/10R simulatneous departures; utility runways on taxiways C, L.

b. These experiments are designed to evaluate the affects of noise abatement procedures.

INPUT DATA FOR EXPERIMENT NUMBER 19

A. LOGISTICS

1. Title: San Francisco International Airport Airfield Simulation Model Experiment 19

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0600-2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Air California	OC
Air Taxi/Commuter	AT
American	AA
Continental	CO
Delta	DL
Flying Tiger	FT
Hughes Airwest	RW
International	IN
National	NA
Northwest	NW
Pacific Southwest	PS
Trans World	TW
United	UA
Western	WA

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

B. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See Figure 1.

10. Number of Runways: 4.

11. Runway Identification: 1L, 1R, 28L and 28R.

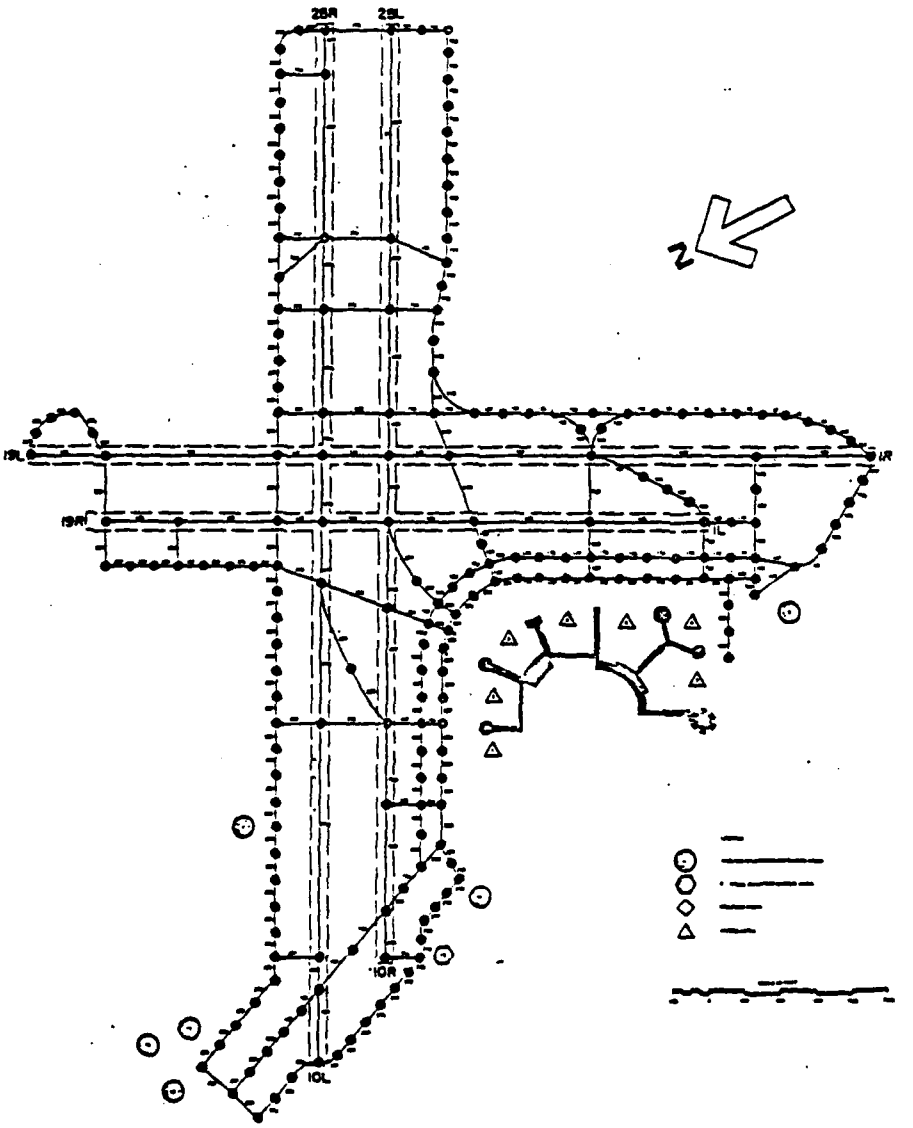


Figure 1

AIRFIELD NETWORK

SAN FRANCISCO INTERNATIONAL AIRPORT

12. Departure Runway End Links: 401, 429, 436

13. Runway Crossing Links: 252, 248, 322, 168, 167, 120, 119

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
28L	J	271	5,800
	E	251	6,600
	D	247	7,900
	R	214	10,500
28R	E	252	6,300
	T	321	6,500
	D	248	8,000
	U	281	10,600
1L	F	120	2,600

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Air California	5
Air Taxi/Commuter	4,5
American	4,5
Continental	4
Delta	4
Flying Tiger	10
Hughes Airwest	3
International	7
National	4
Northwest	4
Pacific Southwest	3,4
Trans World	5,6
United	1,2,3
Western	7

17. General Aviation Basing Areas: Butler Aviation. (Area 13)

C. ATC PROCEDURES

18. Aircraft Separations: These values are based on Report No. FAA-EM-78-8A.

Arrival-Arrival Separation (n.m.)

VFR		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	2.6	2.8	2.8	2.9
	B	2.6	2.8	2.8	2.9
	C	3.4	3.6	2.8	2.9
	D	4.7	4.9	3.9	3.7

IFR		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	3.7	3.9	3.9	4.0
	B	3.7	3.9	3.9	4.0
	C	3.7	3.9	3.9	4.0
	D	4.7	4.9	3.9	4.0

Departure-Departure Separations (seconds)

VFR		Trail Aircraft Class				
		A	B	C	D	
Lead Aircraft Class	A	35	35	45	50	Same Runway
	B	35	35	45	50	
	C	50	50	60	60	
	D	120	120	120	90	

IFR		Trail Aircraft Class				
		A	B	C	D	
Lead Aircraft Class	A	60	60	60	60	Same Runway
	B	60	60	60	60	
	C	60	60	60	60	
	D	120	120	120	90	

Lead Departure Runway	Trail Departure Runway	VFR Separation
1L	28L, 28R	15
1R	28L, 28R	20
28L, 28R	1L	25
28L, 28R	1R	20

Departure-Arrival Separation (n.m.):

		Trail Aircraft Class				
		A	B	C	D	
Lead Aircraft Class	A	0.9	1.1	1.2	1.3	Same Runway
	B	0.9	1.1	1.2	1.3	
	C	1.0	1.3	1.4	1.5	
	D	1.0	1.3	1.4	1.5	

Lead Departure Runway	Trail Arrival Runway	VFR Separation
1L	28L, 28R	1.5
1R	28L, 28R	1.5

Arrival-Departure Separations (minutes)

Arrivals Runways 28L, 28R	Departures Runways 1L, 1R
Class	Separation
A	0.4
B	0.6
C	0.8
D	0.8

19. Route Data: See Figure 2.

20. Two-Way Path Data: Two-way flows occur on connectors between Taxiways A and B.

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
28L	A	2.0
	B	2.0
	C	5.0
	D	5.0
28R	A	2.0
	B	2.0
	C	5.0
	D	5.0
1L	A	2.0
	B	2.0

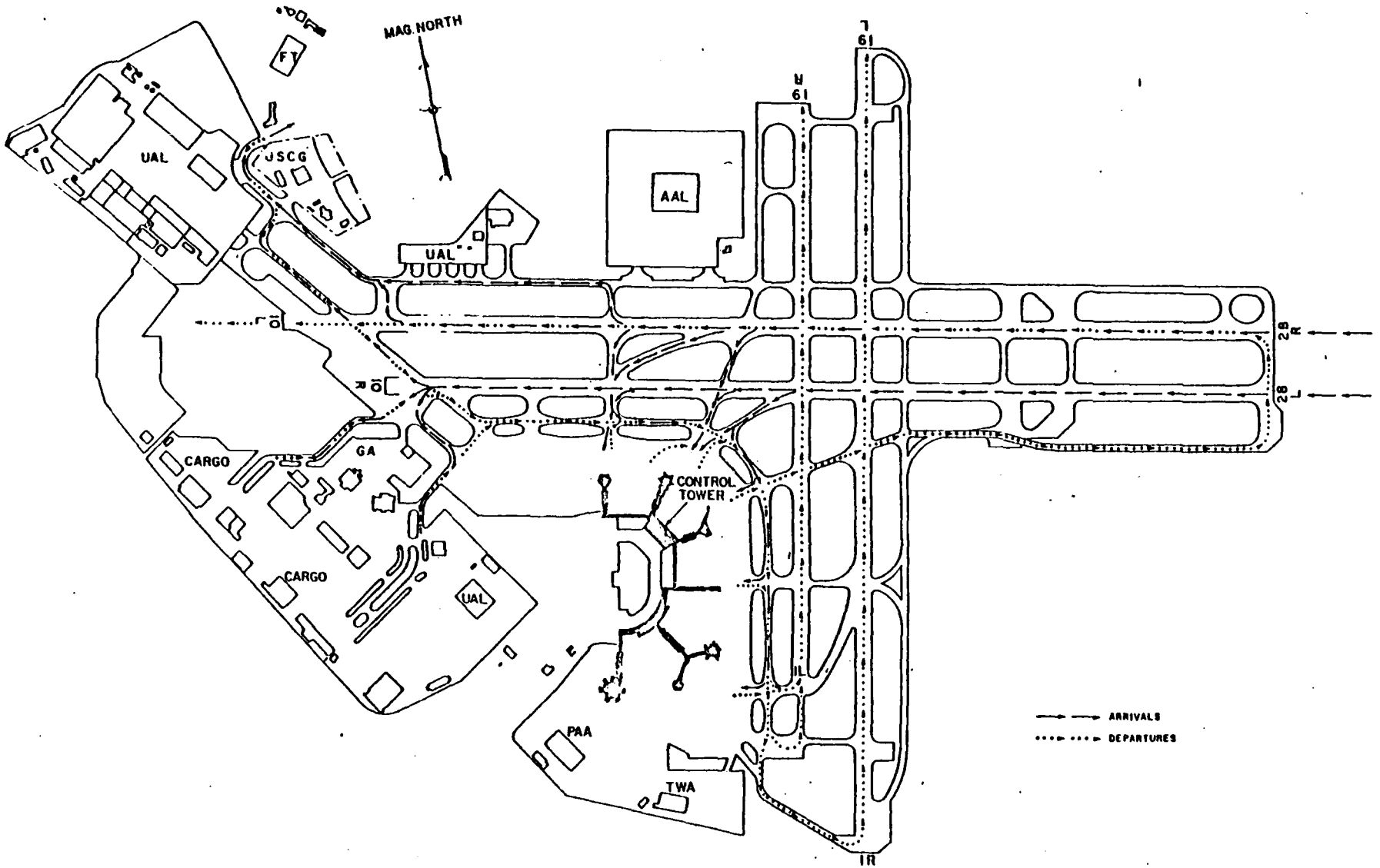


Figure 2. ARRIVAL/DEPARTURE TAXI ROUTES

22. Vectoring Delays:

This input allocates delays among vectoring and holding. Model input values will be used that hold arrival aircraft if delays to arrival aircraft exceed 10 minutes.

23. Departure Runway Queue Control:

Aircraft are assigned departure runways to preclude airspace crossovers, not to balance departure queues.

24. Gate Hold Control:

Aircraft are held at gates when departure queue at runway is 10 or more, except when gate holds would cause gate congestion.

25. Departure Airspace Constraints:

Aircraft are not held at gates due to departure airspace constraints.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are delayed in the arrival airspace when departure delays exceed 15 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 10 minutes or more.

D. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

		Exit Utilization (percent)			
	A/C Class	E	T	D	U
Runway 28R	A		15		85
	B	15			85
	C	63	27	3	7
	D	23	77		

	Exit Utilization (percent)				
	A/C Class	J	E	D	R
Runway 28L	A				100
	B	100			
	C	88	5	5	2
	D	88		12	

	Exit Utilization (percent)	
	A/C Class	F
Runway 1L	A	100
	B	100

29. Arrival Runway Occupancy Times:

	Runway Occupancy Time (seconds)				
	A/C Class	E	T	D	U
Runway 28R	A		80		95
	B	64			102
	C	55	60	92	105
	D	54	54		

	A/C Class	J	E	D	R
Runway 28L	A				75
	B	56			
	C	46	54	63	102
	D	47		75	

	A/C Class	F
Runway 1L	A	40
	B	34

30. Touch & Go Occupancy Times: Not applicable.

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds) Mean	Standard Deviation
A	34	4
B	34	4
C	39	4
D	39	4

32. Taxi Speeds: To be based on reduced field data.

33. Approach Speeds:

Aircraft Class	Approach Speed (knots) Mean	Standard Deviation
A	95	10
B	120	10
C	130	10
D	140	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: To be provided by Task Force.

Table 1

AIRSPACE TRAVEL TIMES[a]
(minutes)
San Francisco Interntational Airport
Stage 1 Experiments: Input Data

Fix	Aircraft Class	Travel Time To Runway	
		R	L
Cedes (1)	1,2	8.5	8.5
	3	10.0	8.5
	4	10.5	8.5
Santa Cruz (2)	1,2	9.5	9.5
	3	11.0	11.0
	4	11.0	11.5
Briny (3)	1.2	10.0	10.0
	3	11.0	11.0
	4	12.0	12.0
Point Reyes (4)	1,2	8.5	11.5
	3	8.5	12.5
	4	8.5	12.5

a. Nominal (undelayed) travel times.

Table 2

ARRIVAL AIRCRAFT LATENESS DISTRIBUTION
(Average deviation from schedule, excluding delays due to destination airport)

Amount of time late or early	Percent of flights late or early (5)
More than 15 min. early	0
less than 15 min. early	3
On time	21
less than 5 minutes late	34
5 to 10 minutes late	16
10 to 15 minutes late	9
15 to 30 minutes late	9
30 to 45 minutes late	3
45 to 60 minutes late	5
more than 60 minutes late	0

Source: Peat, Marwick, Mitchell & Co. analysis of data provided by San Francisco Task Force.

Experiment Number: 20 (Input changes from experiment number 19)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Use IFR1 separations
19 Route data	Include routes for Taxiway C
20 Two-way path data	
21 Common approach paths	All aircraft fly same common approach
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign arrivals to 28R and Taxiway C

b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	

c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	

INPUT DATA FOR EXPERIMENT NUMBER 22

A. LOGISTICS

1. Title: San Francisco International Airport Airfield Simulation Model Experiment 22

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: To be provided by Task Force.

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Air California	OC
Air Taxi/Commuter	AT
American	AA
Continental	CO
Delta	DL
Flying Tiger	FT
Hughes Airwest	RW
International	IN
National	NA
Northwest	NW
Pacific Southwest	PS
Trans World	TW
United	UA
Western	WA

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

B. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See Figure 1.

10. Number of Runways: 4.

11. Runway Identification: 10L, 10R, 19L and 19R.

12. Departure Runway End Links: 410, 421, 422, 430.

13. Runway Crossing Links: 119, 159, 167, 195, 251, 252.

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
19L	F	119	4,700
	G	167	6,300
	H	162	6,400
	M	149	8,000
	B	142	9,500
19R	F	120	4,400
	G	168	5,700
	H	158	7,000

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Air California	5
Air Taxi/Commuter	4,5
American	4,5
Continental	4
Delta	4
Flying Tiger	10
Hughes Airwest	3
International	7
National	4
Northwest	4
Pacific Southwest	3,4
Trans World	5,6
United	1,2,3
Western	7

17. General Aviation Basing Areas: Butler Aviation. (Area 13)

C. ATC PROCEDURES

18. Aircraft Separations: These values are based on Report No. FAA-EM-78-8A.

Arrival-Arrival Separation (n.m.)

VFR		Trail Aircraft Class A	B	C	D
Lead Aircraft Class	A	2.6	2.8	2.8	2.9
	B	2.6	2.8	2.8	2.9
	C	3.4	3.6	2.8	2.9
	D	4.7	4.9	3.9	3.7

IFR		Trail Aircraft Class A	B	C	D
Lead Aircraft Class	A	3.7	3.9	3.9	4.0
	B	3.7	3.9	3.9	4.0
	C	3.7	3.9	3.9	4.0
	D	4.7	4.9	3.9	4.0

Departure-Departure Separations (seconds)

VFR		Trail Aircraft Class A	B	C	D	
Lead Aircraft Class	A	35	35	45	50	Same Runway
	B	35	35	45	50	
	C	50	50	60	60	
	D	120	120	120	90	

IFR		Trail Aircraft Class A	B	C	D	
Lead Aircraft Class	A	60	60	60	60	Same Runway
	B	60	60	60	60	
	C	60	60	60	60	
	D	120	120	120	90	

Lead Departure Runway	Trail Departure Runway	VFR Separation
19R	10L, 10R	10
10L, 10R	19R	35

Departure-Arrival Separation (n.m.):

		Trail Aircraft Class				
		A	B	C	D	
Lead Aircraft Class	A	0.9	1.1	1.2	1.3	Same Runway
	B	0.9	1.1	1.2	1.3	
	C	1.0	1.3	1.4	1.5	
	D	1.0	1.3	1.4	1.5	

Departure Runway	Arrival Runway	VFR Separation
10L, 10R	19L, 19R	3.0

Arrival-Departure Separations (minutes)

Arrivals Runways 19L, 19R	Departures Runways 10L, 10R
Class	Separation
A	0.4
B	0.3
C	0.3
D	0.3

19. Route Data: See Figure 2.

20. Two-Way Path Data: Two-way flows occur on connectors between Taxiways A and B.

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
19L	A	2.0
	B	2.0
	C	5.0
	D	5.0
19R	A	2.0
	B	2.0
	C	5.0
	D	5.0

22. Vectoring Delays:

This input allocates delays among vectoring and holding. Model input values will be used that hold arrival aircraft if delays to arrival aircraft exceed 10 minutes.

23. Departure Runway Queue Control:

Aircraft are assigned departure runways to preclude airspace crossovers, not to balance departure queues.

24. Gate Hold Control:

Aircraft are held at gates when departure queue at runway is 10 or more, except when gate holds would cause gate congestion.

25. Departure Airspace Constraints:

Aircraft are not held at gates due to departure airspace constraints.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are delayed in the arrival airspace when departure delays exceed 15 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 10 minutes or more.

D. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

		Exit Utilization (percent)		
	A/C Class	F	G	H
Runway 19L	A	100		
	B	100		
	C	30	30	40
	D	0	10	90

		Exit Utilization (percent)		
	A/C Class	F	G	H
Runway 19R	A	100		
	B	100		
	C	20	65	15
	D			100

29. Arrival Runway Occupancy Times:

		Runway Occupancy Time (seconds)		
	A/C Class	F	G	H
Runway 19L	A	63		
	B	53		
	C	44	55	55
	D		55	55

	A/C Class	F	G	H
Runway 19R	A	58		
	B	50		
	C	42	53	65
	D			65

30. Touch & Go Occupancy Times: Not applicable.

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds) Mean	Standard Deviation
A	34	4
B	34	4
C	39	4
D	39	4

32. Taxi Speeds: To be based on reduced field data.

33. Approach Speeds:

Aircraft Class	Approach Speed (knots) Mean	Standard Deviation
A	95	10
B	120	10
C	130	10
D	140	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: To be provided by Task Force.

Experiment Number: 23 (Input changes from experiment number 22)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	IFR2 Separations
19 Route data	
20 Two-way path data	
21 Common approach paths	All aircraft fly same common approach
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	IFR runway occupancy times
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign arrival and departure runways

INPUT DATA FOR EXPERIMENT NUMBER 24

1. Annual Demand: To be estimated by Task Force.

2. Group Specification:

3 day groups	:	High, Average, Low
12 week groups	:	12 months, January through December
4 weather groups	:	VFR1, VFR2, IFR1, IFR2

7 runway uses :	Arrivals Runway	Departures Runway
1.	28 L/R	1 L/R
2.	28 L or R	1 L/R
3.	28 L/R	1 L or R
4.	28 L/R	28 L/R
5.	19 L/R	10 L/R
6.	19 L/R	19 L/R
7.	Other*	Other*

3,4. Traffic Distribution:

Week Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% of annual in one week	1.79	1.79	1.90	1.91	1.86	1.97	2.02	2.05	1.99	1.95	1.93	1.84
Number of weeks in month	4.43	4.00	4.43	4.29	4.43	4.29	4.43	4.43	4.29	4.43	4.29	4.43
% of annual in month	7.90	7.14	8.40	8.15	8.21	8.42	8.92	9.05	8.80	8.62	8.26	8.13

5,6. Daily Traffic Distribution:

Day Group	High	Avg	Low
% of weekly in one day	15.1	14.1	12.3
Number of days	3	3	1
% of weekly traffic in day group	45.3	42.4	12.3

*Includes Land 10 L/R, Depart 10 L/R and Land 1 L/R, Depart 1 L/R.

7. Weather Occurrences:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% VFR1	76	83	80	89	80	80	80	72	76	84	84	69
% VFR2	16	10	18	8	15	15	13	15	15	12	11	14
% IFR1	3	1	1	2	2	3	3	5	3	1	1	4
% IFR2	5	6	1	1	3	2	4	8	6	3	4	13

8. Hourly Runway Capacity Parameters:

	Hourly Capacity[a] (Operations/hour)			
Runway Use	VFR1	VFR2	IFR1	IFR2
1	(b)	(b)	(b)	(b)
2	(b)	(b)	(b)	(b)
3	(b)	(b)	(b)	(b)
4	(b)	(b)	(b)	(b)
5	(b)	(b)	(b)	(b)
6	(b)	(b)	(b)	(b)
7	(b)	(b)	(b)	(b)

9. Runway Use/Weather Group Demand Factors:

For all runway uses:

Weather			
VFR1	VFR2	IFR1	IFR2
1.0	1.0	0.98	0.81

10. Runway Use Occurrences:[c]

	Percent Occurrence				
Runway Use	VFR1	VFR2	IFR1	IFR2	All Weather
1	46.3	5.1	1.8	3.8	57.0
2	2.4	1.6	-	-	4.0
3	5.0	1.0	-	-	6.0
4	24.3	0.3	0.2	0.2	25.0
5	1.0	4.0	0.5	0.5	6.0
6	-	0.6	0.2	0.2	1.0
7	0.2	0.8	-	-	1.0
All Runways	79.2	13.4	2.7	4.7	100.0

(a) Federal Aviation Administration, San Francisco International Airport Staff-ATA-Airlines serving San Francisco-*San Francisco International Airport Operations Improvement Program-Interim Report*-September 1977.

(b) To be estimated by Task Force with PMM&Co. assistance.

(c) To be estimated by Task Force.

11. Hourly Traffic:

Hour	% Daily Traffic	Hour	% Daily Traffic	Hour	% Daily Traffic	Hour	% Daily Traffic
00-01	2.6	06-07	1.6	12-13	7.1	18-19	5.5
01-02	1.6	07-08	4.6	13-14	6.6	19-20	6.2
02-03	0.9	08-09	6.1	14-15	6.4	20-21	5.1
03-04	0.7	09-10	6.2	15-16	5.2	21-22	3.8
04-05	0.4	10-11	5.7	16-17	5.0	22-23	3.9
05-06	1.0	11-12	6.0	17-18	5.2	23-24	2.6

12,13. Delay Curve Specification: To be determined after airfield simulation runs.

14. Percent Arrivals:

Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals
00-01	44	06-07	34	12-13	49	18-19	59
01-02	43	07-08	43	13-14	46	19-20	57
02-03	60	08-09	40	14-15	49	20-21	62
03-04	67	09-10	40	15-16	49	21-22	57
04-05	65	10-11	51	16-17	52	22-23	44
05-06	50	11-12	61	17-18	46	23-24	65

15. Cancellation Diversion Specification: 60, 120, 0.25

16. User-Specified Title: SFO Experiment 24.

INPUT DATA FOR EXPERIMENTS 25 THROUGH 33

Experiment Number	Page Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
24	83	ADM	n.a.	n.a.	n.a.	1982	Today	None
25	86	ADM	n.a.	n.a.	n.a.	1982	Today	All
26	86	ADM	n.a.	n.a.	n.a.	1982	1982	All
27	86	ADM	n.a.[a]	n.a.[a]	n.a.	1982	1982	None
28	86	ADM	n.a.[a]	n.a.[a]	n.a.	1982	1982	All
29	86	ADM	n.a.	n.a.	n.a.	1987	Today	None
30	86	ADM	n.a.	n.a.	n.a.	1987	Today	All
31	86	ADM	n.a.	n.a.	n.a.	1987	1987	All
32	86	ADM	n.a.[a]	n.a.[a]	n.a.	1987	1987	None
33	86	ADM	n.a.[a]	n.a.[a]	n.a.	1987	1987	All

a. These experiments are designed to evaluate the affects of noise abatement procedures.

Experiments 25 through 28 will use the same input data as Experiment 24 except that runway capacities will be revised to reflect the various ATC scenarios and near-term improvements.

Experiments 29 through 33 will use the same input data as Experiments 24 through 28 respectively, except that the annual demand will be revised according to Task Force Inputs.